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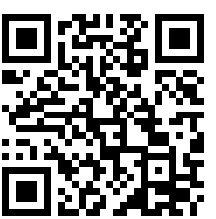

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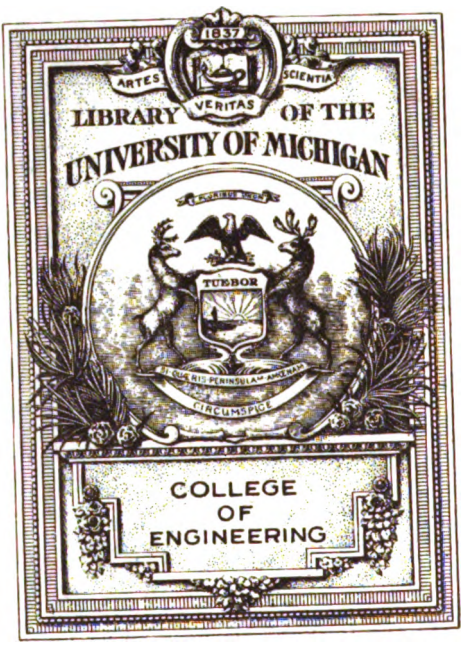

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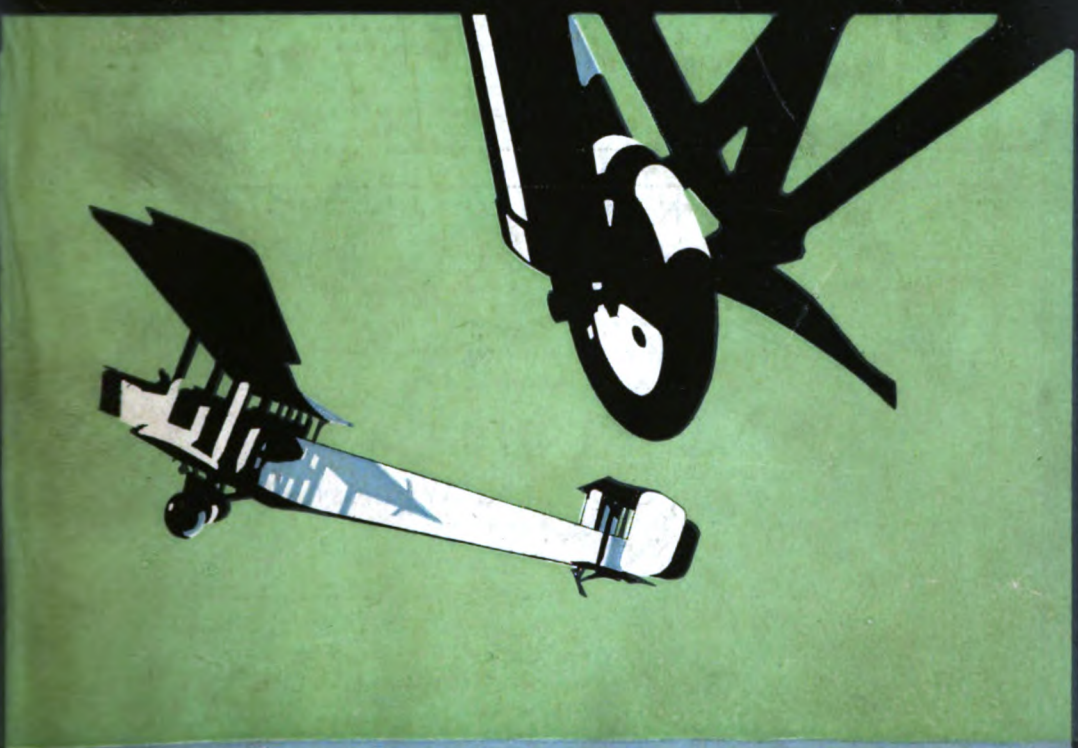

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THE
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APRIL
1919

Great Wireless Stations.

POLDHU.

TO the ocean travelling public and to a large section of the stay-at-home community probably there is no better known high-power wireless station in these islands than that which is situated at Poldhu (sometimes spelt Poljew) in Cornwall, and it may be said with certainty that this station, or at any rate its immediate locality, is in a sense the Mecca of those workers who are interested, professionally or otherwise, in the practice and progress of radiotelegraphy. For it was here, appropriately at the beginning of the twentieth century, that Senatore Marconi erected the world's first high-power wireless plant and from here was sent the first wireless communication to be detected on the other side of the Atlantic.

Constructional work was begun in October, 1900, on a site which had been selected near the village of Mullion, after preliminary tests of transmission between the Isle of Wight and the Lizard had been performed with a view to finding out what effect the curvature of the earth would have upon the emitted waves. By the autumn of 1901 the transmitting arrangements were well advanced, when a September gale played havoc with the masts—twenty 200-feet masts arranged in a circle 100 feet in radius—and occasioned a delay of some five weeks. However, at the end of this period Senatore Marconi was able to proceed to Newfoundland with his assistants and apparatus in order to make his final arrangements for the momentous experiment. Arriving at St. Johns early in December he succeeded, in spite of adverse weather, in elevating an aerial by means of a kite, and on December 12th, 1901, it was established beyond doubt that the pre-arranged signals, a series of the letter "S," were being received from Poldhu. The wavelength employed was about 2,000 metres, an interesting fact not generally known.

Thus with a transmitter of some 10 or 12 k.w. power, and an aerial composed of fifty bare stranded copper wires stretched between two masts 160 feet high and 200 feet apart, modern long dis-

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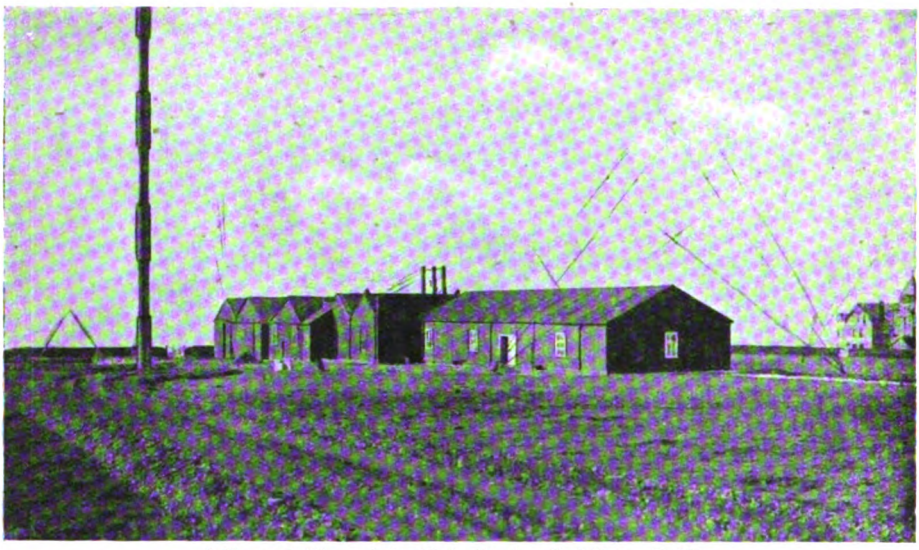

A General View of the Main Station Buildings, Poldhu.

tance wireless telegraphy was foreshadowed. Steps were at once taken to erect a permanent station on the American side, and this would have been situated in Newfoundland, but owing to the fact that a cable company possessed the landing rights it was not possible to instal it there and eventually the Glace Bay (Nova Scotia) station was built. In the meantime alterations were made at Poldhu, wooden lattice-work towers replaced the original ring of masts, the aerial was enlarged, more plant was put in, and a transatlantic wireless service became at length an accomplished fact.

The present day plant which we shall presently describe is rated at 75 k.w. or more than six times the power originally used, and has been continuously employed during the war, not only in the delivery of war warnings and the usual nightly press service to ships but also in combating the Hun by means of transmitting official propaganda programmes.

The transmitting aerial, which is supported by four steel tubular and two wooden masts, is approximately 1,800 feet long and 200 feet high and consists of 16 wires arranged in two sets of 8 parallel wires. The receiving aerial is composed of two wires each elevated by three masts.

The receiving house is situated on the edge of the cliff some 100 yards distant from the main station and comprises two rooms, one of which is devoted to the ordinary implements of landline telegraphy. The other room contains the receiving apparatus; this is of the most up-to-date type, and includes the super-sensitive three-electrode hard valve detector and amplifier which was described in a recent issue of this magazine. As an illustration of the value of these new receivers we may mention that on one occasion at Poldhu good signals were received from Nauen, a distance of about 800 miles, the aerial employed being a few turns of bell wire wound on a wooden box *inside* the receiving room. Arrangements for the reception and recording on wax cylinders of automatically transmitted high-speed signals are also installed, for during the war high-speed work was largely adopted by a number of foreign stations and it became

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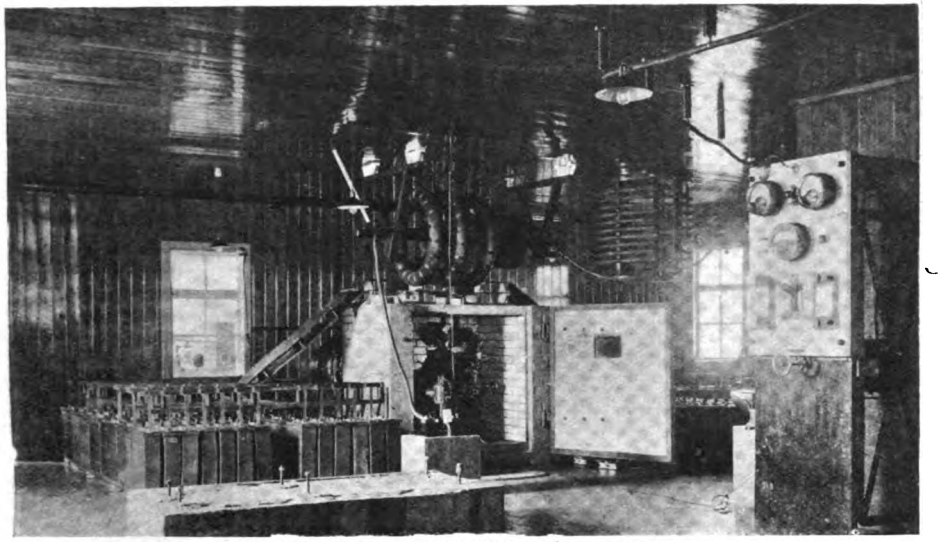

The 75 k.w. Transmitting Apparatus.

necessary to provide for reception at speeds ranging from thirty-five to sixty words per minute.

Auxiliary and emergency apparatus such as the Magnetic Detector and the balanced crystal tuner for the detection of long waves complete the equipment of the station as regards reception.

The buildings of the main station include the transmitting room, engine room and boiler house, workshop, carpenter's shop, stores and offices, constituting a model establishment for a modern radio station.

The transmitting room contains in addition to the newest installation the gear which was used until a short time before the outbreak of war. The new transmitting set is of the synchronous type, the disc, alternator and exciter being driven by a 110 H.P. De Laval turbine running at 2,100 r.p.m. The disc is of copper and is furnished with twelve 3-inch copper studs, the side discs being rotated by means of cycle chain and worm gear from the end of the alternator shaft.

The 75 k.w. alternator supplies current at 2,000 v. (200 cycles), to three 25 k.w. oil-immersed transformers which are connected in parallel giving a secondary pressure of 13,000 v. which, in accordance with the newer practice, is placed directly across the spark-gaps. The H.T. mains are provided with protecting chokes consisting of No. 16 d.c.c. wire wound on wooden frames in four sections of 225 turns, two of these frames being connected in series with each main. The low frequency tuning inductance is air cooled and is supported on two ordinary earthen drainpipes.

The condenser system is composed of two banks of 91 "pots" all connected in parallel, with the exception of twenty-seven which are kept ready in position as spares. The "pots" which are of earthenware each contain two gallons of oil, in which are immersed seven zinc plates ($13\frac{1}{2}$-in. by $12\frac{3}{4}$-in.) and twenty glass plates 3 mm. in thickness; these are arranged in the order of 3 glass plates between two of zinc.

The jigger primary consists of two turns, $24\frac{1}{2}$-in. in internal diameter, built up of a hundred strands of 7/20 S.W.G.

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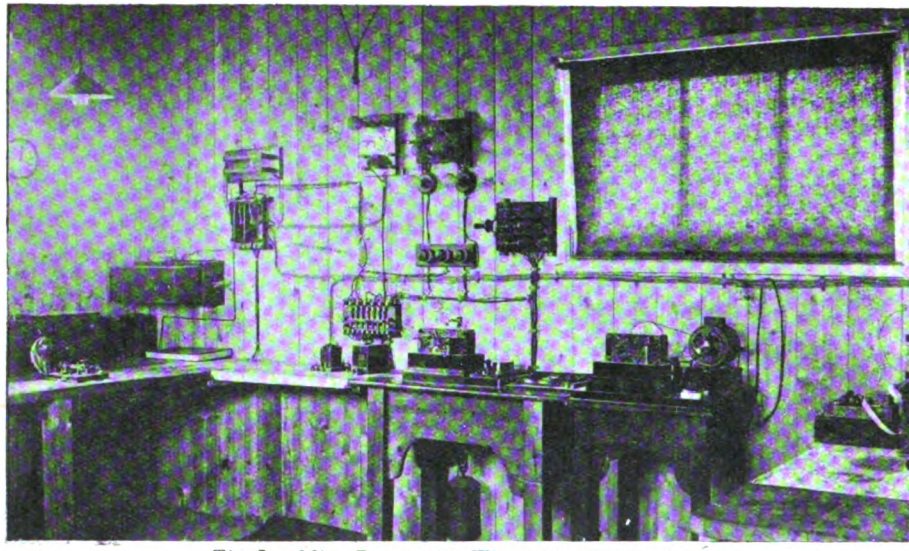

The Land-line Room with Wheatstone Transmitter.

wire, placed on a 5-in. wooden core. It is of interest to note that these two turns do not form a helix but are mounted in parallel planes and coupled by a 7-in. by 1/16-in. copper strip. The secondary winding of the jigger consists of seven turns of braided flex on a 17-diameter circular wooden frame; this and the primary winding can be seen in detail in our illustration, though of the three primary turns shown only two are in circuit. The aerial tuning inductance has ten turns of stranded wire, on a wooden frame of 38-in. diameter, supported from the ceilling with its longitudinal axis vertical. There is no separate H.F. tuning inductance as the circuit is permanently adjusted by means of the condensers and the jigger primary.

The boiler house which is separated from the adjacent rooms by a wall with fireproof doors, contains three " Robey " Loco type boilers (12-in. by 3-ft. 6-in. barrel) working at 150 lbs. per square inch and here also there are two duplex steam feed pumps of the Worthington type. Water is drawn from the cooling pond through a Rankine filter and passes through a Ledward and Beckett tubular feed heater which utilises the exhaust from the pumps. This cooling pond is about 40 yards from the condenser and takes the form of an unlined pit, the dimensions of which are 22 yards by 22 yards and about 10 feet depth. In winter there are roughly 3 feet 6 inches of water standing in this, but in the summer an auxiliary supply is obtained from the steam pumping station in Poldhu Cove. A special filter pit, from which water is drawn for the ejector condenser, is connected to the cooling pond by a tunnel. The pumping station in the Cove has two horizontal duplex pumps, which take steam from a 6 H.P. vertical cross tube boiler and supply the cooling pond through a $2\frac{1}{2}$-in. main.

The engine and turbine exhaust into an ejector jet condenser which is supplied by a Laval turbine-driven centrifugal pump, the normal vacuum being from 28-in. to 30-in.; the usual automatic vacuum breaker is fitted, and there is an alternative exhaust to atmosphere.

As a point of interest in connection

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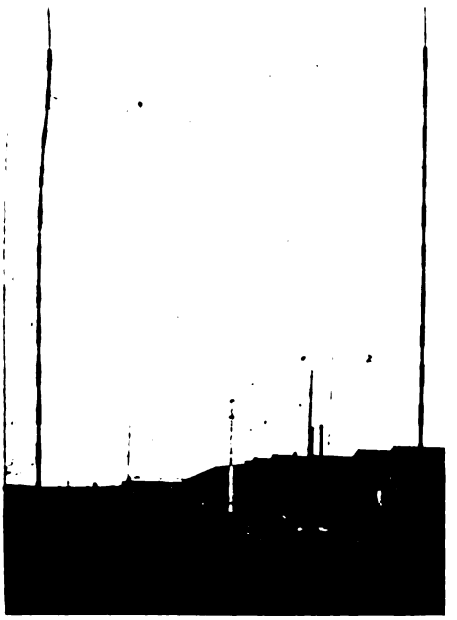
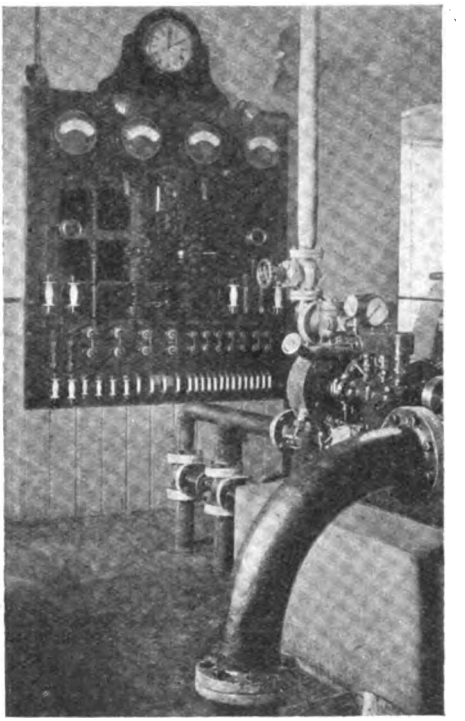
with constructional detail we may mention that the discs are housed in a brick chamber five feet high, provided with a wooden door in which are glazed windows, and ventilated by Sirocco type blowers which draw through 12-in. ducts.

Our readers are doubtless well aware of the great service rendered to navigators by the time signals which are sent out twice daily from the Eiffel Tower wireless station and will therefore be interested to learn that before the Gotha, as a dropper of bombs, disappeared from the air, complete preparations were made to carry on from Poldhu the invaluable work of time-signalling in the event of the destruction of Eiffel Tower station.

The normal transmitting wavelength employed by Poldhu is 2,800 metres and the daylight range is given as 1,800 miles.



The Aerial System.



A Switchboard in the Machine Room.

Transatlantic Wireless Telephony

ON March 19th it was announced by Marconi's Wireless Telegraph Company, Limited, that they had succeeded in establishing wireless telephone communication between Ballybunion, Ireland, and Louisburg, Cape Breton Is., Canada. Fuller particulars of this remarkable feat will be published in our next issue.

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CAPTAIN SLEE

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Personalities in the Wireless World

CAPTAIN SLEE, the Chairman of The Wireless Board, of which particulars are given on page 27, was born in May, 1878, at Wimbledon. Destined for the Navy, he entered the training ship "Britannia," and in 1894 made his first voyage to China, as midshipman on H.M.S. "Centurion." On this vessel he remained three years and then, according to the usual procedure, took his sailing course on board the brig "Nautilus." On completing this branch of instruction he qualified for his commission and already, early in his career, gave evidence of particular ability by obtaining four firsts out of the possible five in the examinations.

As Sub-Lieutenant the young officer then served on the destroyer "Decoy" and in the same capacity on the destroyer "Ernest" until 1899, when he was promoted Lieutenant. He then proceeded to the battleship "Anson," in the Mediterranean, and thence to the cruiser "Severn," after which he took the "long course" to qualify as torpedo Lieutenant. On obtaining this rank Captain Slee spent a year on the staff of the "Defiance," at Devonport, and here, in 1901, gained his first wireless experience.

Proceeding once more to the Mediterranean he spent two years on the battleship "Montagu," this experience being followed by six months on the battleship "Empress of India," stationed at Devonport. In May, 1906, he was attached to H.M.S. "Queen," but in August of that year, owing to eyesight trouble,—the after effects of an attack of typhoid,—he had to relinquish this position and has since held shore appointments.

For two years after leaving the "Queen" he served as Wireless Telegraph Experimental Officer on the "Vernon," at Portsmouth, and from 1908 until last year was in charge of all Naval wireless stations and War signal stations in Great Britain.

He was promoted to the rank of Acting Commander in 1913 and Acting Captain in 1918. On the formation of The Wireless Board Captain Slee was appointed head of the Board, in which capacity he has since served.

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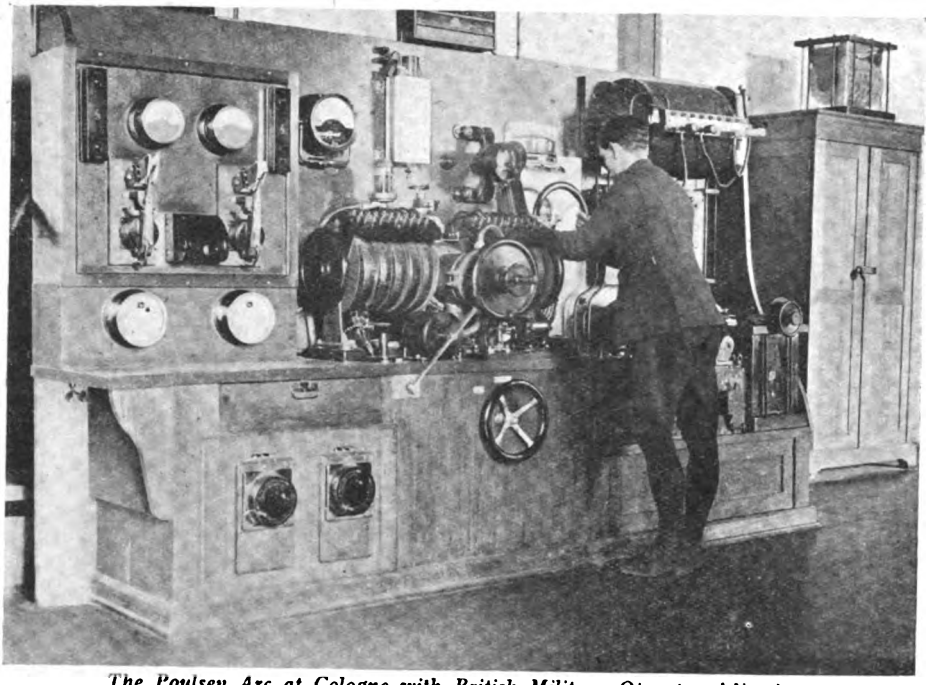
The Poulsen Wireless System

Its Origin and Development

ONE of the interesting features of radiotelegraphic progress in the last four years has been the extension in the use of the arc as a generator of high frequency oscillations. From the letters we receive from time to time it is evident that many of our readers desire to obtain a general idea of the principles and working of the Poulsen system, and the following article has been penned with that end in view.

The arc method of generating continuous oscillations for radiotelegraphy and telephony may be said to have had its origin in the pioneer work of the well-known scientist Mr. William Duddell, who in 1900 discovered the phenomenon known generally as the "singing arc." In the course of investigation he found that if a direct current arc be shunted by capacity and inductance in the manner shown in Fig. 1 the arc will commence to emit a musical note approximately equal in frequency to that of the circuit formed by the arc, capacity, and inductance.

By Duddell's arrangement, however,



The Poulsen Arc at Cologne with British Military Operator Adjusting.

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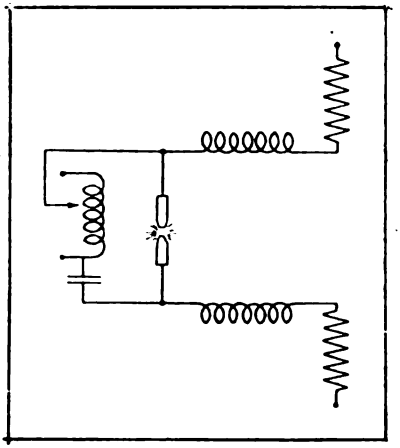

Fig. 1. The Duddell Arc Circuit.

it was not possible to obtain frequencies high enough for radiotelegraphy, as the value of the shunted condenser and inductance needed to be very large.

In the year 1903 a Danish scientist, Dr. Valdemar Poulsen, introduced two highly important modifications of the Duddell arc which immediately made this device a practical generator of high frequency oscillations of the order and power required for radiotelegraphy. The first of these consisted in striking the arc in a sealed chamber containing hydrogen or hydro-carbon gas and the second consisted in placing the arc itself in an intense transverse magnetic field. By these two modifications both the frequency and the power of the arc were considerably augmented. Other improvements of the apparatus introduced by Poulsen consisted in making the positive electrode of copper cooled by a constant flow of water and in rotating the carbon electrode to equalise the burning and consequently to increase the steadiness of the arc.

A general idea of the first Poulsen arrangement is given in Fig. 2. Fig. 3 shows how the arc itself being a current bearing conductor is deflected by the magnetic field.

Professor Pedersen, the well-known Danish physicist, has collaborated with Dr. Poulsen in evolving the system. The Professor has been attached for a considerable number of years to the Royal College of Engineering in Copenhagen,—a college which has been established for more than a century.

In order to understand the principle upon which the Poulsen arc works and to grasp the importance of Poulsen's fundamental patents, we must now consider the Duddell arc and the peculiar property it possesses, by virtue of which it differs from an ordinary metallic conductor: it does not follow Ohms Law.

It is well known by all students that in a solid conductor the current flowing is dependent upon the voltage applied and as we increase the voltage so the current will increase until the material melts or evaporates. According to the electron theory now generally accepted conductors contain in their interatomic spaces free electrons or atoms of negative electricity. A current is said to flow

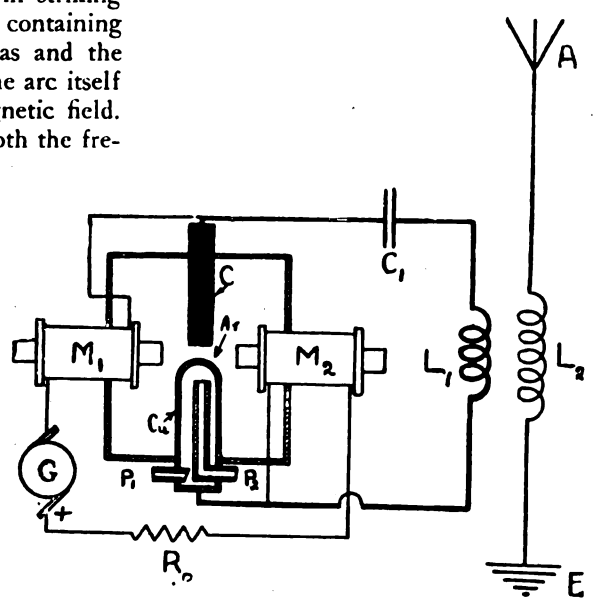

Fig. 2.

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when a general drift of the free electrons takes place in one direction. In the case of a gas or vapour this body is not a conductor unless there exist free negative and positive charges called ions. Molecules of a gas can be ionised by the impact of electrons or ions thrown into them and, as a matter of fact, this is what happens in the case of an arc. When the arc is struck the incandescent negative electrode emits electrons which ionise the gas, the negative ions being pushed towards the positive electrode and the positive towards the negative electrode. Obviously if the ions are removed from the field as quickly as they are produced the current will be stationary and will not increase beyond a certain strength which is known as the saturation value. In this connection we cannot do better than quote Dr. J. A. Fleming who says: "Hence in a gaseous "conductor the current does not increase "steadily with the potential difference "of the electrodes but tends towards a "limiting value. Also it is clear that as "the ions are moved towards the elec- "trodes unless these latter remove them "or absorb them sufficiently quickly the "accumulation of negative ions near the "positive electrodes and of positive ions "near the negative electrodes will "diminish the potential difference of the "electrode and create that condition in "which the increase of current—that is "increase in migrations of ions—causes "a decrease in the potential difference of "the electrodes. In this case then we "shall have a falling characteristic, or "volt-ampere, curve."

We are now in a better position to understand what happens when the capacity and inductance of the Duddell arc are connected across the arc electrodes. The moment the condenser is joined to the two arc electrodes electricity flows into it and this momentarily reduces the current through the arc. This reduction as explained above is accompanied by an immediate increase in the potential difference of the carbons, and this again results in more current flowing into the condenser. Hence the condenser becomes charged to the full voltage or potential difference of the carbons. This condition is, however, unstable. The condenser begins at once to discharge back through the arc thus increasing the arc current. The result is that the potential difference of the carbons decreases and the discharge is still more facilitated. The condenser being in series with the inductance is over-discharged or given the equivalent of a reversed charge. The whole cycle of operations is then repeated and the condenser and inductance circuit charges and discharges with a frequency determined by the natural frequency of the whole circuit. It will be seen that the energy of oscillation is drawn from the battery or dynamo supplying the direct current to the arc.

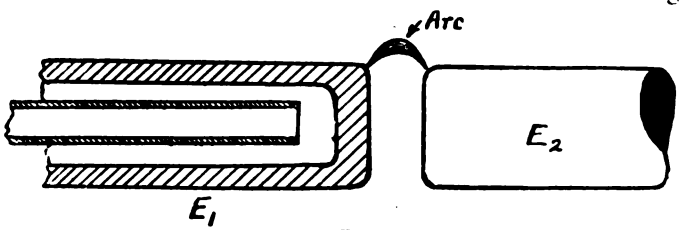

Fig. 3.

In the case of the Duddell arc in air between two carbon electrodes the increase of current did not bring about a large decrease of voltage or, as we say, the falling characteristic was not very steep, and the associated condenser had to be large for the effect to be perceptible.

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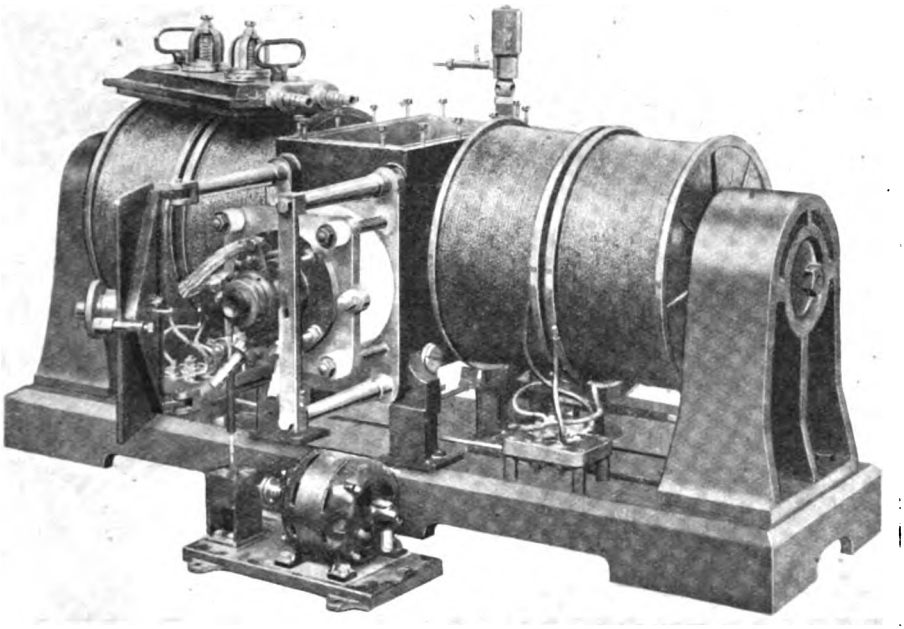

A 200 kilowatt Poulsen Arc with lid of Arc Chamber removed.

As the inductance had also to be large only low frequencies were attained. Further, owing to the presence of oxygen many of the positively charged carbon ions combine with the negatively charged oxygen ions form carbon di-oxide and as a consequence many of the ions which would otherwise go to reduce the potential of the gap as previously explained were withdrawn. Poulsen by placing the arc in hydrogen prevented this wastage and thereby brought about a steepening of the curve, or an increase of voltage drop with rise of current. Smaller condensers could thus be used, with higher frequencies.

The introduction of the strong transverse magnetic field had very important effects. In the Duddell arrangement the arc itself is never extinguished but only diminished and increased in intensity. In many cases in the normal Poulsen arc the magnetic field blows out or de-ionises the arc once in every oscillation. The advantage of blowing out the arc each time is that the full supply voltage is then available for charging the condenser, power being considerably increased thereby. The arc is re-struck as soon as the voltage of the condenser rises to a certain value. Another advantage of the magnetic field is that the arc can be lengthened or stretched out for a very short electrode separation, this latter facilitating the re-ignition. The hydrogen or hydro-carbon gas probably assists the de-ionisation in addition to its other functions. The cycle of events in the Poulsen arc where it is extinguished is thus, condenser charge, arc ignition, condenser discharge and reverse charge, reduction of arc current by opposed condenser current, extinction of arc, neutralisation of the reversed condenser charge by D.C. generator, new charge, re-ignition of arc, and so on indefinitely.

The early Poulsen transmitter, then,

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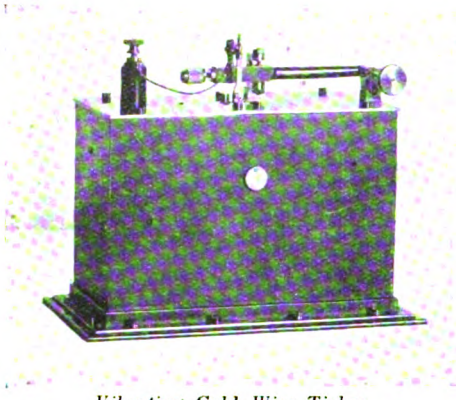
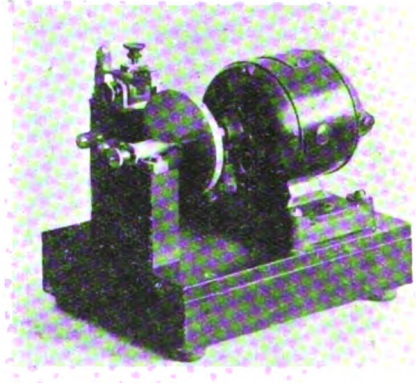


Vibrating Gold Wire Ticker.

consisted of a source of direct-current supply (usually a dynamo) the water cooled arc, the associated capacity and inductance and the usual aerial and earth inductively coupled to the closed oscillating circuit. As it was not practicable to start and stop the arc by means of a telegraph key for transmitting signals and as it was desirable from several points of view,—and particularly for steadiness,—to keep the arc in continual operation, an arrangement was made whereby signals were sent by slightly varying the wavelength. The normal radiation from the arc can be called the "spacing" or "compensating" wave while the shorter wavelength caused by the short circuiting of certain turns of aerial inductance is the "signalling" wave. If then the receiving operator tunes to the signalling waves he will hear only the Morse signals sent by the transmitting operator. Owing to the sharp tuning resulting from the use of continuous waves it is only necessary to alter the wavelength slightly when sending.

On the receiving side an inductively coupled tuner was fitted, tuning being very sharp owing to the fact that continuous and not damped waves were sent out from the transmitting station. In the case of spark signals the note heard in the receiving telephones is that of the spark frequency of the transmitter. In the case of undamped waves, where radiation is continuous and not divided up into wave trains, it is necessary to provide some means of obtaining an audible note, such as by breaking up the stream of oscillations into groups of an audible frequency. In the early Poulsen stations the receiving device was known as the "ticker" and consisted merely of a form of interrupter by which a condenser in the receiving circuit was periodically discharged through the telephones at a convenient frequency. Several forms of ticker were made, some consisting merely of a vibrating contact between two gold wires, others of a rubbing contact between a wire and a metal disc and still others being similar in form to a rotary contact breaker.

In time it was found practicable to abandon the use of a closed oscillating circuit, and the arc is now connected directly to the aerial and earth, the capacity and inductance of which acts exactly in the same manner as in the closed circuit of Fig. 2. Several advantages arise out of this arrangement, among them being that no coupling of a closed to an open circuit is necessary, and the whole plant is considerably simplified. The general transmitting circuits for a station are well shown in the



Rotary Ticker.

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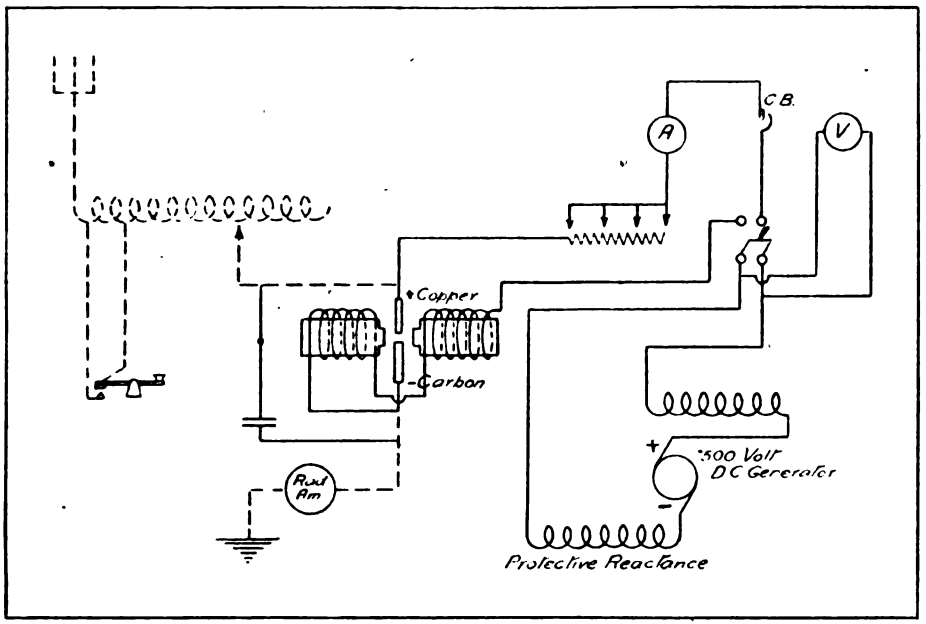

Fig. 4. The Transmitting Circuit at Washington (Arlington).

diagram on page 13 which indicates the arc circuits at Washington (Arlington). The purpose of the condenser across the arc will be explained later.

In the last few years the Poulsen arc has been considerably improved and has now become much more reliable in operation. It has now been proved that all parts of the apparatus must be designed to suit the power, wavelength and aerial used in each case. The most convenient means of providing the necessary hydro-carbon atmosphere has been found to be that of automatically dropping alcohol into the arc chamber where it is immediately vaporised. To equalise wear the carbon electrode is rotated automatically by means of a geared-down electric motor, and is automatically fed in, while the cooling arrangements for the positive pole and the arc chamber itself have reached a high degree of perfection. Without the cooling arrangements the copper pole would, of course, vaporise in a very few minutes. Single arcs are now frequently made to carry a power as high as 100 kilowatts and in a few cases much more powerful installations have been erected. At the present time we understand that the construction of a one-thousand kilowatt arc is well under way in America and in this case practically the whole device is immersed in oil for cooling. Thus, although no fundamental change has been made in the apparatus since it was first invented by Dr. Poulsen, considerable progress in engineering details has removed the arc from the state of an interesting but an erratic laboratory instrument into the front rank of wireless transmitters. There are, however, still a number of difficulties to be overcome in connection with the steadiness of the arc on high powers, in signalling and in freeing the radiation from unwanted harmonics. Further, although the efficiency of conversion from direct current to high frequency current is fairly high (in the neighbourhood of 40 per cent.) the whole of the energy in the space wave is wasted and over-all efficiency is low.

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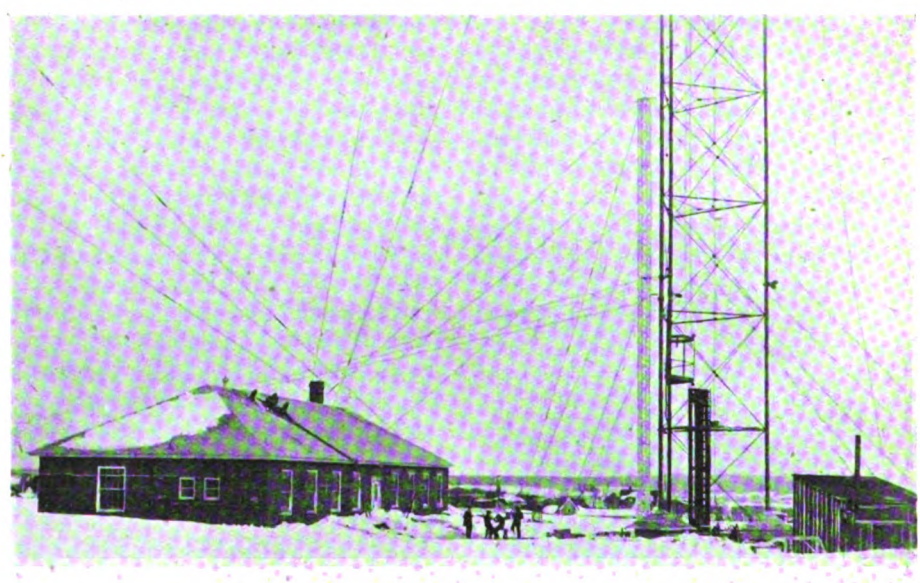
In the United States the Federal Telegraph Company which works in conjunction with the Poulsen Wireless Corporation of San Francisco have introduced one or two modifications of circuits perhaps the most interesting being that shown in our diagram on page 13 wherein a large condenser is shunted across the arc. This has the effect of considerably increasing the arc current and has enabled the higher power installations to be erected.

The United States Naval Authorities have erected Poulsen Stations at San Diego in California, at Pearl Harbour in the Sandwich Islands, and at Cavité in the Phillipine Islands, the stations being respectively of 200, 500 and 500 kw. at the dynamo terminals.

The recent developments in the valve amplifier and receiver, and in continuous wave receivers generally have greatly increased the value of the arc transmitter, but as we have published articles on several occasions regarding continuous wave reception we do not think it necessary to enter into details of receivers here. In the press some information has lately appeared with reference to later installations. Thus it is known that besides the powerful arc at the Eiffel Tower a still more important plant has been erected at Lyons, and a new wireless station on the Poulsen system has been in course of construction at a point near Bordeaux. This station was begun by the American Government but owing to the termination of hostilities it has been sold in an incomplete condition to the French Government for a large sum. This station has four masts 275 metres high and the power of the station on completion will be in the neighbourhood of 1100 kw. This station will, therefore, be in the front rank of high power installations and as the Lyons plant has been reported as communicating regularly with Shanghai some highly interesting long distance developments will probably ensue.



The Poulsen Station at Newcastle, N.B., Canada.

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Digest of Wireless Literature

HIGH FREQ. MACHINES OF THE INDUCTOR TYPE. *By M. Osnos. Jahrb. der dr. tel. Vol. 13, Part 4.*

THE H. F. machine has attracted a great deal of attention ever since the advent of Wireless Telegraphy. The most frequently proposed construction belongs to the so-called Inductor type (with the notable exception of the Goldschmidt machine), and it is a matter of not merely historical interest that all modern generators of this type can be derived from the machines described by Cail-Hermer and Guy in their patents taken out in 1892 (French patent No. 226,781) and 1901 (German patent No. 143,630) respectively.

The usual construction of such an alternator of the inductor type is shown on Fig. 1, where P_1 denotes the stator and P_2 the rotor. It will be seen that both the exciting and A.C. windings (W_e and W) are arranged on the stator. The action of the machine depends on the periodical variation of the reluctance of the magnetic circuit, which is at its minimum when the poles of the rotor and stator are in opposition and at its maximum—when the poles of the rotor are facing the intervals between the poles of the stator.

Since the relative position of rotor and stator at any moment t is exactly repeated next at the moment $t + T$ where T is the time required for an angular displacement of the rotor as determined by the pitch, it is obvious that the frequency of such an alternator will be given by

$$p \times n,$$

where p is the number of poles, and n is the number of revs. per second.

It follows that in order to obtain a high frequency, p must be very large since n is limited by mechanical considerations. A high number of poles, however, involves a small space for winding. Cail-Hermer, therefore, proposed the construction shown on Fig. 2. It will be seen that each pole is sub-divided into a comparatively large number of teeth. Although the windings are arranged exactly in the same way as on Fig. 1, the interval between two consecutive identical positions of the rotor relatively

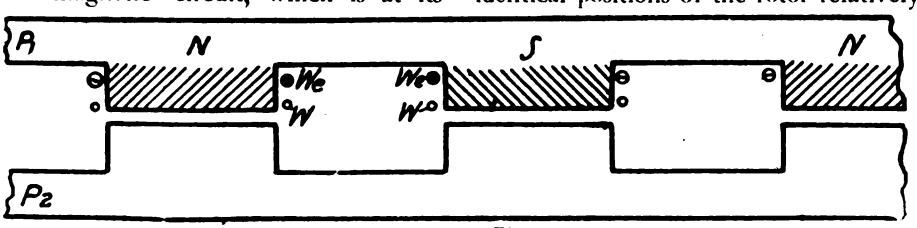

Fig. 1.

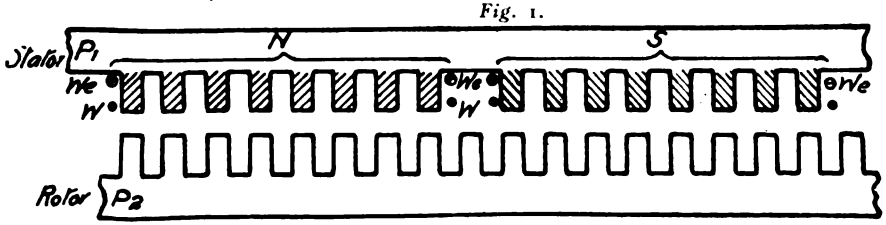

Fig. 2.

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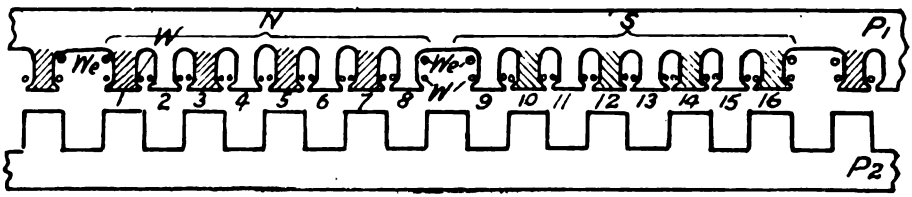

Fig. 3.

to the stator will be now determined by the pitch between the teeth, and the frequency will therefore be :

$$p_1 \times n$$

where p_1 is the number of teeth on the rotor. It is obvious that at the same number of revolutions Cail-Hermer's machine will possess a frequency times larger than that obtainable with the ordinary construction.

The main drawback of this machine consists in the H.F. currents induced in the exciting winding. In order to suppress these currents, it is usual to introduce into the field circuit choking coils. The latter may, however, become very bulky, for the D.C. which necessarily flows through them tends to saturate the iron and thereby to diminish the inductance of these coils. Large masses of iron have therefore to be employed in order to keep the cores as far as possible from saturation, with t' e result that the choking coils may require more room than the machine itself.

It has been proposed to obviate this difficulty by employing two identical machines which are mechanically so coupled that when the teeth of the rotor face the teeth of the stator in one machine, the teeth of the rotor in the other machine face the intervals between the teeth of its stator. Since the currents induced in both machines will have a phase difference of 180°, the undesirable currents in the exciting windings can be eliminated by connecting them in opposition (the A.C. windings being, of course, connected to form a series arrangement). This method, however, has the inconveniency of entailing the use of two machines.

A far simpler solution is given by the construction shown in Fig. 3. The pitch between the teeth of the stator is here half of that on the rotor. Owing to this the total reluctance the magnetic circuit remains constant for all positions of the rotor and no currents will therefore be induced in the exciting windings which embrace the whole pole. But on the other hand, we cannot any more, arrange the A.C. windings coaxially with exciting coils (as in Fig. 2), for no currents will then be induced in them either. We shall have therefore to wind each tooth separately (as shown in Fig. 3), for the variations of flux are now limited to the teeth alone. The frequency obtainable from such a machine will still be determined as in the other cases, by the product of the number of teeth on the rotor and the number of revs. per second. It will also be seen that, since the currents induced in the coils embracing the shaded and unshaded teeth differ in phase by 180°, the connections between the consecutive coils will have to be made in such a manner that the E.M.Fs. should add.

The construction of this type of generator is sometimes modified as shown in Figs. 4 and 4A. By arranging the poles on both sides of the exciting coil, the machine is made homopolar, for all poles on one face of the stator will be of one sign. It is clear that the homopolar type differs from the machine shown on Fig. 3 only in so far as mechanical construction is concerned. Electrically, both machines are identical. The method given in Fig. 3 for the suppression of the H.F. currents in the exciting winding of the Cail-Hermer

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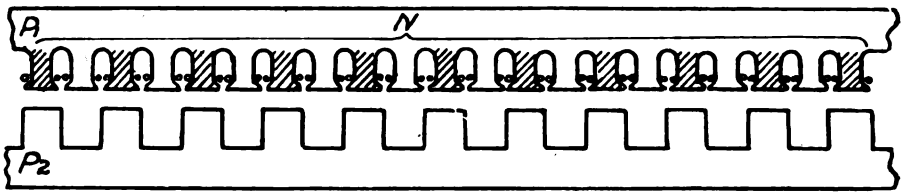

Fig. 4.

machine although very effective involves, however, a considerable increase in the number of the A.C. windings as compared with the original arrangement shown in Fig. 2.

A further improvement, which allows of having a small number of A.C. coils while obviating the generation of H.F. currents in the exciting winding, has been proposed by M. Guy in his patent mentioned above.

As shown in Fig. 5, by shading, the teeth on each pole of the stator are split up into two groups. At a moment when the teeth (shaded) belonging to one group face the teeth of the rotor, the teeth (unshaded) belonging to the other group face the intervals between the teeth of the rotor.

The total flux through a pole will therefore remain constant (as in Fig. 3), but periodical variations will take place in each group of teeth. It follows that the A.C. windings can be arranged now to embrace one half of a pole (as shown on Fig. 5 by $a-b$; $c-d$; $e-f$; $g-h$), and their number will be reduced to twice the number of poles.

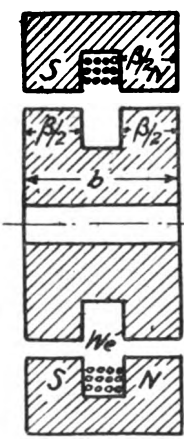

Fig. 4a.

A little consideration will, however, show that we can go still further and reduce the number of A.C. windings to the number of poles. Let us assume that in the position shown on Fig. 5, the E.M.F. induced in coil $a-b$ is such that the current flows from $a-c$. We mark then a with + and b with −. The next group of shaded teeth, embraced by coil $e-f$, belong to a south pole, therefore we shall have to mark e with − and f with +.

As to coils $c-d$ and $g-h$, which embrace the groups of unshaded teeth, the E.M.Fs. induced in them will differ in phase by 180° from the E.M.F. induced in coils $a-c$ and $e-f$. It follows that c and h will have to be marked with $a-$ and d and $g-$ with $a+$. An inspection of the obtained results will show at once that conductors d, e, which lie in the same recess cancel each other and can therefore be omitted. On the other hand conductors f, g, and b, c, do not cancel each other. The result is that for each two coils such as $c-d$ and $e-f$ we can substitute one coil $e-f$. The number of A.C. windings can

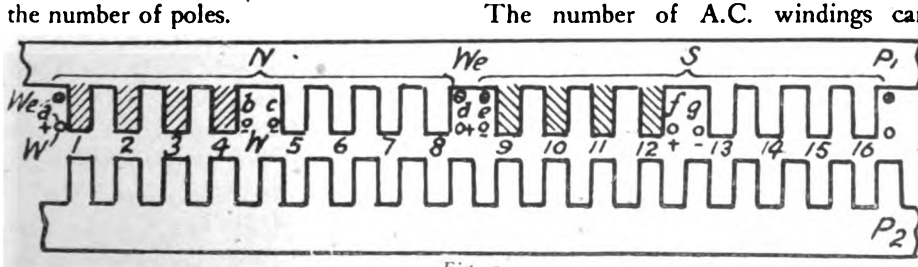

Fig. 5.

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therefore be made equal to the number of poles. It will also be noticed that by this arrangement an increase in the space available for winding is obtained, for all the recesses between consecutive poles will contain conductors carrying D.C. only. We can express it in other words by saying that the D.C. and A.C. windings are displaced relatively to each other by 90°.

The action of M. Guy's machine can also be explained in the following more direct manner. Let us take a bi-polar machine (see Fig. 6) in which the exciting winding W_e is arranged at right angles to the A.C. winding W. The teeth on the poles which face at the given moment the teeth of the rotor (the shaded teeth in Fig. 5) are represented by the thick lines *I* and *III*. It is obvious that almost the whole magnetic flux will follow the path of smallest reluctance, and can therefore be represented by N_{13} which on being resolved gives the component N^{I}_{13} and N^{II}_{13}. Half a period afterwards, the teeth *II* and *IV* will be just opposite the teeth of the rotor and the flux will have the direction N_{24}. Resolving again into two components we obtain N^{I}_{13} N^{II}_{13}. We see then that the component N^{I}_{13} remains constant and therefore can induce no currents either in W_e or W. As to the other component, it has changed in direction, and currents will be induced in W. The winding W_e, on the other hand, will be unaffected, for the variable component lies in its plane. For any intermediate position of the rotor, the *direction* of the component N remains the same, for the resultant N lies always on the same side of the vertical axis (*i.e.*, N will never fall in quadrants *II* and *III*). On the other hand the *magnitude* of horizontal component may vary, but the variations will be comparatively small and a little consideration will show that the A.C. currents induced by them in W_e will possess a higher frequency than those induced by the vertical component in the winding W. Owing to this, the undesirable currents can be easily suppressed.

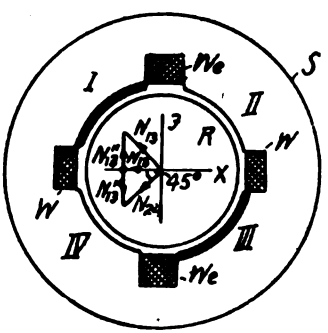

Fig. 6.

A limiting case of the Guy alternator is shown on Fig. 7. Each pole has only two teeth and their arrangement relatively to the rotor teeth is very similar to the one shown on Fig. 3, The method of winding shows, however, the characteristic feature of M. Guy's machines, for the exciting winding W_e is at right angles to the A.C. winding W.

The modification shown on Fig. 7. is due to the author and is protected by the German patent No. 267,798 belonging to the A.E.G.

In conclusion, the author points out that M. Guy's machine can easily be converted into the homopolar type in the same way as Figs. 4 and 4A have been obtained from Fig. 3.

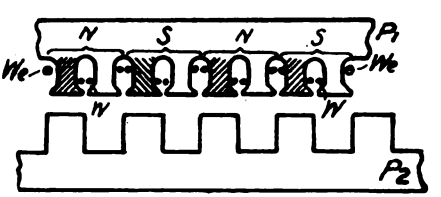

Fig. 7.

ON THE ELECTRICAL OPERATION AND MECHANICAL DESIGN OF AN IMPULSE EXCITATION MULTI-SPARK GROUP RADIO TRANSMITTER.

By B. Washington.

The article, which does not lend itself very well to abstracting, describes the

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wireless apparatus as manufactured by the firm of Cutting and Washington.

The discharger is of the quenched spark type, the electrodes being either aluminium - copper, copper - copper, or silver-silver. In all cases the discharger is placed in an airtight chamber, alcohol being fed through a wick. The distance between the electrodes varies between .02 and .36 mm.

It would appear that this spark-gap being carefully adjusted will give a unidirectional discharge. The number of oscillations in the antenna occurring between two successive discharges which is called by the author "inverse charge frequency" can be made very small and an oscillogram is shown where the inverse frequency is equal to one. By careful adjustment of the circuits, continuous oscillations may be generated.

The source of supply may be either a D.C. or A.C. generator (in the present article only sets with A.C. generators are described). In order to obtain a good note, it has been found that a homopolar machine, consisting of two stators and an unwound rotor between them is the most suitable. In order to further secure a pure and steady note, a circuit consisting of a capacity and inductance in series and having a period of approximately 1,500 cycles, is placed across the primary condenser.

Owing to the very thorough quenching, no sharp tuning is required; so, for instance, when the primary was tuned to a wave of 850 metres, the secondary could be varied between 490 and 670 metres without affecting the value of the antenna current.

The author gives in conclusion a description of some of the sets manufactured by his firm. The various apparatus are assembled on panels of "bakelite dilecto," and a $\frac{1}{2}$ k.w. transmitter has an overall dimension of 14-in. by 28-in. by 18-in. In the receiver, a crystal, apparently of the type requiring no auxiliary E.M.F., is employed and the secondary is of the aperiodic type.

RESONANCE MEASUREMENTS IN RADIO-TELEGRAPHY.

By L. W. Austin.

(Washington Acad., Sc. 19.8.1918, p 498. "Science Abstracts," Section B, 31.10.1918, p. 388.)

The author draws the attention of Wireless Engineers to the utilization for the measuring purposes of the click, which is heard in the telephones of an oscillating valve circuit, when it is brought into resonance with another circuit at the proper coupling. The latter has to be varied until the click occurs at the same division of the variable condenser, independently of whether the resonance point is reached by increasing the capacity, or by decreasing it.

The author illustrates the method of application by describing the measurement (1) of the capacity of an antenna, and (2) of the wavelength of an incoming oscillation.

In the first case, a large inductance (about 25 times that of the antenna) is introduced into the aerial, and the oscillating audion circuit is properly coupled with the antenna and brought into resonance with the latter by the click test. The inductance is then disconnected from the antenna and ground, and connected to a variable condenser. The latter is so adjusted as to bring the circuit into resonance with the oscillating valve circuit. The reading of the condenser then gives the capacity of the antenna, subject to a small correction for the antenna inductance.

In the second case, the receiver is first accurately tuned to the incoming wave; the wavemeter is then coupled to the secondary circuit, and adjusted to resonance by the click method. The reading

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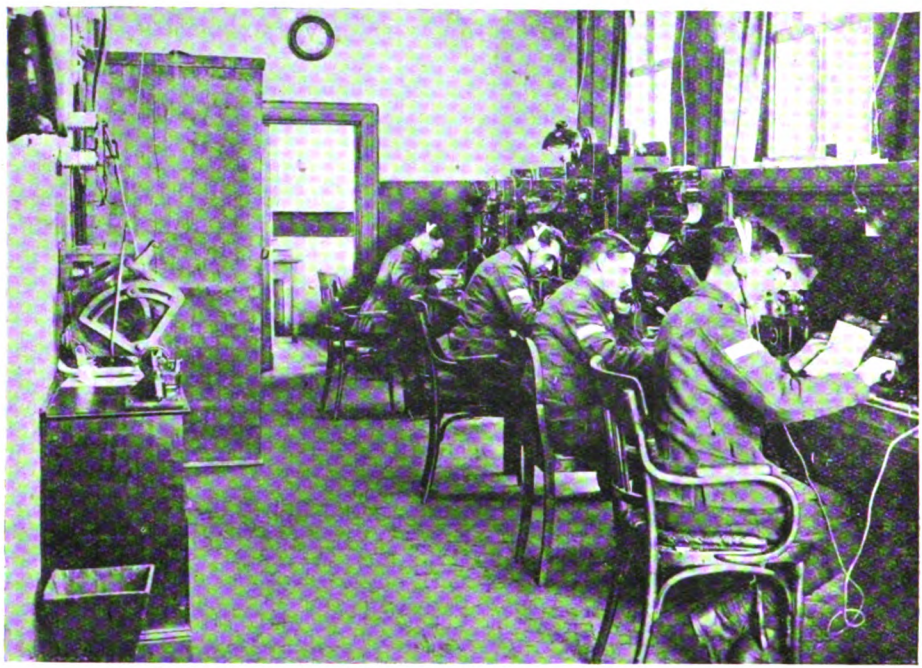
of the wavemeter gives the wavelength of the sending station.

It will be seen that this method dispenses with all additional apparatus in the wavemeter, and would make possible very accurate measurements even in places where sensitive galvanometers cannot be employed.



British Operators at Work in the German Station at Cologne.

WIRELESS IN THE ARCTIC.

When the Crocker Land Expedition left New York for the Arctic in 1913 it carried with it what we think must be the most ambitious electrical outfit ever taken to within a few degrees of the Pole. In addition to a wireless installation the Expedition had the advantage of a complete 3-kw. generating plant charging an 80 ampere-hour accumulator battery of 125 volts pressure, an electric oven, electric stoves and lamps.

According to an article in the *General Electric Review* for January, "The attempt at radio-communication was disappointing." The cause of the trouble was, as usual, the difficulty of keeping the antenna aloft and an attempt to elevate it on kites was defeated because of the gustiness of the wind. In this connection we reca'l that Scott suffered from the same cause when he tried to charge his accumulators with a windmill as a prime mover, and as in Scott's case the wind dissipated his hopes by taking the windmill some distance with it, so two puppies cut the communications of the Crocker Expedition by making a bed of the last unbroken kite. It is stated by the writer of the article that no "static" or other effect was noticed as a result of the Aurora, but as there is no indication that anything at all was received by wireless we are inclined to think that this observation is not reliable. The experience of operators on ships entering the Arctic circle shows that, as a rule, the "atmospherics" noticed during a display of the Aurora are very strong.

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"Forward Wireless" in Battle

The Last Phase before the Armistice

By C. A. Oliver, Wireless Officer, 25th Division.

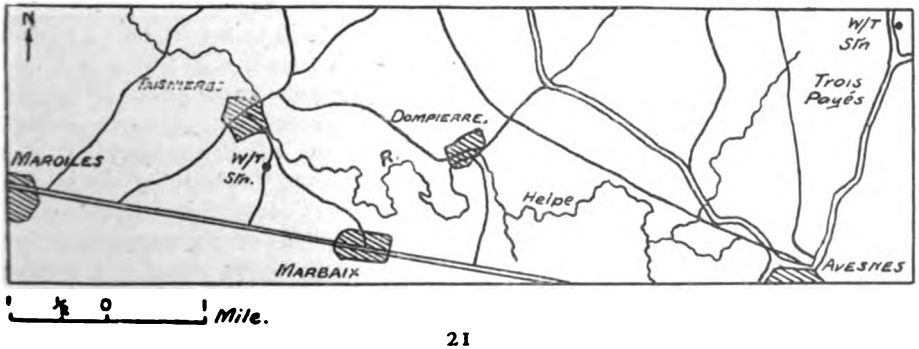
WHEN a Maritime Wireless man takes up Land Wireless he finds himself confronted with a number of difficulties which he seldom if ever experienced at sea. At sea, for instance, he had a heavy set which took up a comparatively large space, and he was able to obtain a large and efficient current from the ship's dynamo to either work his set from direct or to charge his accumulators with; on land, however, he finds that he must be able easily to transport his set from one place to another, and it must be compact and light in weight in consequence, he also finds that his source of energy must be small and compact.

C. A. Oliver. *Photo A. Spencer*

This means that whereas at sea his set could be large and of great power, his portable land set must be small and of strictly limited power.

This in turn presents the difficulty of actual wireless communication over adequate distances so that the wireless may be of real practical value. In this respect the nature of the country is an important factor to be considered. The Wireless Officer must be able to sum up country by looking at it, and settle in his own mind how the means at his disposal can be set forth to the best advantage. A miscalculation in this respect may mean the temporary failure of his entire current system of wireless communication.

In the last great



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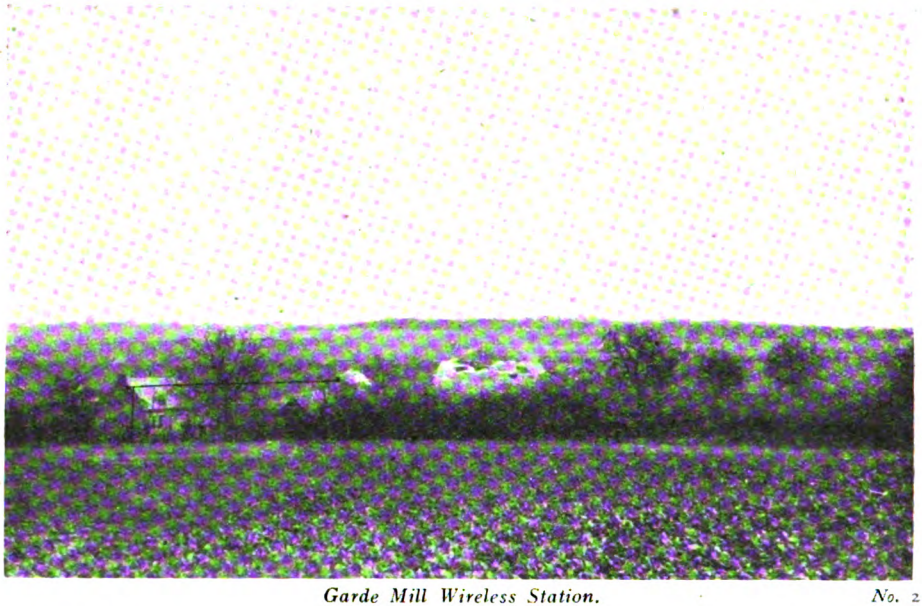

Garde Mill Wireless Station. *No. 2*

battles before the Armistice on November 11th, two distinct types of country were encountered about the centre of the British Front. The first was rolling country interspersed with small villages and sunken roads—the second type was close country cut up by hedges and trees, and consisting very largely of wooded hills and valleys.

Another important factor to be considered by the Wireless Officer is that his entire system of communication may have to be altered and possibly carried forward at very short notice; he must therefore be prepared to move his stations rapidly to any selected spots and establish his new system of communication almost, if not quite, as soon as his old system has been abandoned.

The question of the supply of electrical power must naturally be given the greatest attention, and as accumulators to a large extent form the source of power, the collecting, charging and redistribution of these heavy articles needs careful forethought; the more rapidly the Army advances the closer must be the attention given to this matter if stations are to be adequately supplied with electrical power.

It will therefore be clearly seen that the standard of efficiency of the Wireless Service on land must be of the highest degree in order that the Wireless communications may be of real value to a Unit or group of Units in the field. Not only must the general outline and details of the system be carefully thought out, but each man in the wireless system must be trained to the highest degree of efficiency in his own respective job. In order to review the forward wireless work during the great advance leading up to the culminating point of Armistice Day, it will be best to take a Sector of the battle front and follow out the wireless progress made in it. On the 22nd of October one Division found itself in the neighbourhood of Le Cateau, with its Units lying out in the direction of Pommereuil. Pommereuil —a small village on the outskirts of the Bois l'Evecque—was as yet in German hands. It had been decided that a Wire-

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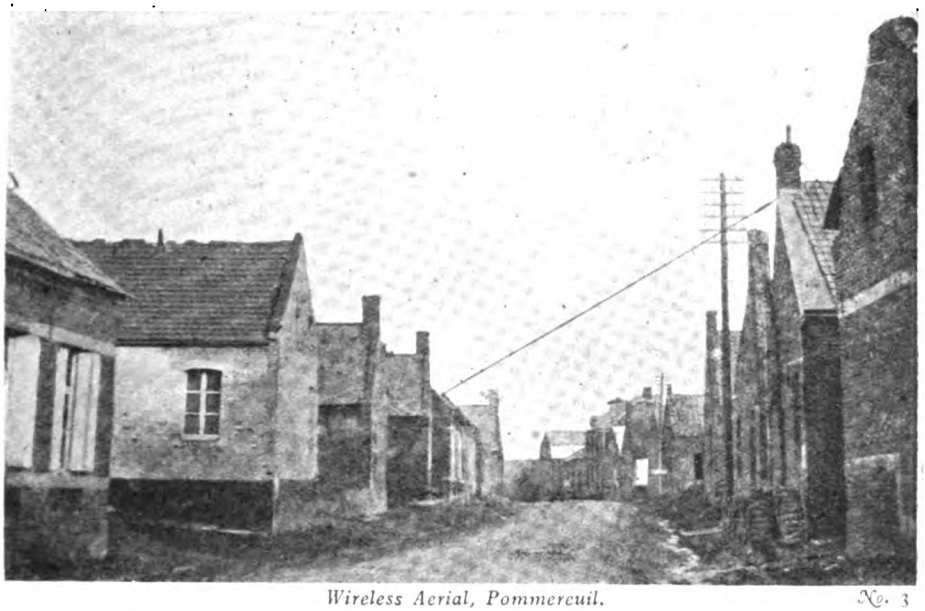

Wireless Aerial, Pommereuil. No. 3

less Station should be established as soon as possible at Garde Mill, a cluster of farm houses in a small valley situated to the west and at the foot of Pommereuil. Later when the enemy had been driven from Pommereuil village two Wireless Stations were to be established in the neighbourhood of Pommereuil itself.

At dawn on the 23rd our troops attacked, and in face of fierce resistance from the Pommereuil slopes and the Bois l'Evecque carried the valley and the slopes beyond. The Wireless Station destined for Garde Mill pushed gallantly forward at the same time despite heavy machine gun and shell fire, and established itself early at Garde Mill.

The result of the prompt action of this resolute little party was that early reliable communication was established from a very forward area back to the rearmost Wireless Station, and information as to the progress of the battle could be got back without delay.

When a Station is wanted quickly it is not always possible to erect the very best of aerials until a little time has elapsed. The Garde Mill aerial was at first run from a point half way up one of the farm buildings, but was later raised to the roof. The old general rule of "the higher the aerial the better the communication" holds good on land as well as at sea. The Garde Mill Station itself was in the cellar of a farm house.

Later, according to programme, two Wireless Stations were established in the Pommereuil area; one of these Stations is shown in the second photograph.

It may be noticed from the photographs that it was possible to utilise houses for supporting the wireless aerials. This indicates a distinct change from the phase of warfare such as was experienced in the Somme area. There it was the exception to find a building standing at all, and so the portable masts, which are carried by every Wireless Station, had to be erected. However, the addition in height usually afforded by a building is often preferable to the use of the portable wireless mast, and in the last phase of warfare before the Armistice the enemy was being pushed back for the

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Tilleul Farm W.T. Station. No. 4

most part so rapidly that in many cases buildings were not damaged at all by shot and shell, and it was possible to utilise them to a very large extent for supporting the aerials. This in addition to saving the erection of a mast, more often than not gave a considerable increase to the height of an aerial.

The Pommereuil Stations were able to work back direct to the rearmost station of the Unit near Le Cateau, and also to the station at Garde Mill. Later the Garde Mill Station was found to be unnecessary and was consequently closed down and withdrawn.

The front line by this time had reached the eastern outskirts of the Bois l'Evecque, and a Wireless Station was rapidly run out and established under some difficulties at Tilleul Farm. This station utilised the farm building for one aerial support and erected a 15-feet portable mast to support the distant end of the aerial. The station proved of the utmost value, especially during times when the telegraph and telephone lines had been cut up by shell fire. In such cases the entire traffic of the lines in this area would be taken over and disposed of by the Wireless Station.

The great drawback where all cases of emergency of this sort arise is that all secret messages must be put into cypher, and naturally a small delay must occur while this is being done, and a similar delay at the other end while the message is being deciphered. This, of course, must always be a source of trouble with all wireless communications as we know them to-day, since anyone with a similarly tuned wireless set can pick up the messages. Hence, the enemy could if he wished pick up all our wireless work, but if it was in cypher it would be of little if any use to him. Unimportant messages were always transmitted in "clear," that is to say, in English.

Wooded country is always apt to offer resistance to wireless work, and a close scrutiny of the Bois l'Evecque was necessary before it could be decided what would be the most advantageous way of utilising the available wireless sets.

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W.T. Malgarni. No. 5

The Bois l'Evecque is for the most part now composed of shrubs and bushes a few feet high, tall trees only existing in parts; the Bosch had cut down most of the stouter timber, probably for making supports for his famous deep dug-outs, which still exist all over the country. In consequence the resistance offered to the wireless waves was not great between Tilleul Farm and the Pommereuil Station, and work was carried on without interruption.

Much more difficulty was experienced with the Malgarni Station which was sent forward and erected in that village in the early days of November. Whereas with the Tilleul Farm-Pommereuil communication only a corner of the wood had to be overcome, with the Malgarni - Pommereuil communication the whole of the wood had to be traversed, and in some parts of this route the trees of the Bois were full grown and tall, and therefore tended to break up the ether waves to a much greater extent. Also the country differed considerably from the Garde Mill area. There the country was open, composed of rolling hills and valleys; round about the Bois l'Evecque the land began to change to "close country," and at Malgarni it was found to be entirely composed of small fields divided by tall thick hedges, of orchards and tall trees, and on the western side the Bois l'Evecque itself.

The first aerial erected at Malgarni was run out along the main street, the distant end being supported by the gable end of a house. At the home end a portable mast was erected on the upper part of a building, and sticking up through a hole in the roof which some obliging shell had torn open a short time before. This method afforded a good additional height for the aerial above the normal level of the roof. An insulated lead-in wire led from the aerial down into the cellar where the instruments were situated.

Malgarni was shelled at intervals by the enemy, but the aerial withstood all assaults and was never broken. The village was entirely deserted by civilians

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Landrecies Aerial. No. 6

with the exception of one bent old lady who kept a cow there and remained through all the strife of battle. She had been there during the German occupation, had passed as if by a miracle through the struggle of battle while the village was being wrested from German hands by the British, and now that the line rested but a short distance from her native village and her home was being bombarded by German shells she still remained, unhurt and unalarmed; and she was still there when the Germans were driven back for all time from the neighbourhood.

The position of the front line was at this time beginning to see some rapid changes, and whereas before the Bosch had taken the trouble to evacuate civilians before retiring himself in front of the advancing Allies, he now found all his work cut out for him in getting his own troops back, and had consequently no time to evacuate the civilians. He, however, found time to drive most of their live stock away with him! Our front line often consisted of outposts at farms and houses occupied by civilians, in the next house but a few yards away might be one of the Bosch outposts. One little party of refugees coming down from the front line said that an English patrol had visited their farm in the morning, and the Bosch in the afternoon; when again the British returned that night the civilians left their farm and went back with the patrol into the British lines and safety.

Early in November the British line pushed forward again, wireless stations were established at points midway between Landrecies and Malgarni, the Malgarni Station then becoming a pivotal point for all the wireless traffic of that area. The day before this the aerial of this station was altered considerably, a 30-feet portable mast was erected in a field to the west of the station and the aerial swung round and fastened to it. Thus instead of the aerial running approximately north and south, its direction was east and west.

(To be continued.)

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The Wireless Telegraphy Board

Co-ordination in the Wireless Services

WITH the widespread use of radiotelegraphy and telephony in the Army, Navy and Air Force, it has become necessary to form a Committee for the purpose of bringing together those who are directly responsible for radiotelegraphy and telephony in those forces. The Committee which bears the official name, the Wireless Telegraphy Board, has already been in existence for over a year, meetings being held at frequent intervals,—on the average once a week.

According to the Navy List for February, the following members represent the forces in question:—

Head of Board—Captain (Act.) J. A. Slee, R.N.

Naval Members—Commander B. Buxton, D.S.O., R.N.; Commander G. C. Candy, R.N.; Major S. C. Wace, R.M.A.

Military Members—Lieut.-Col. Ll. Evans, D.S.O., R.E.; Major A. Simpson C.M.G., R.E.

Air Force Members—Colonel L. F. Blandy, D.S.O., R.A.F.; Lieut.-Col. G. P. Grenfell, D.S.O., R.A.F.

The Military Member, Major (now Colonel) A. Simpson, has, however, resigned as it was necessary for him to leave the country in order to take up a post in H.M. Forces abroad. His place was taken for a time by Captain P. J. Edmunds, but this officer has now resigned for other duties, his seat being occupied by Captain Moorshead. Captain Slee, the head of the Board, is well known in wireless telegraph circles, and his portrait together with biographical particulars appears on pages 6 and 7 of this issue.

Of the Naval Members Commander Buxton, D.S.O., R.N., represents the Department of Naval Intelligence at the Admiralty and Commander Candy the Department of Torpedoes and Mines. This latter Department is responsible for the whole of the wireless telegraph installations on board vessels of the Fleet as well as for the fitting of wireless telegraphy on the numerous trawlers, minesweepers and other Fleet auxiliaries.

Major (now Lieut.-Colonel) Wace was born in 1883, educated at Shrewsbury Schools and entered the Royal Marine Artillery in 1901. In 1908 he became assistant for wireless telegraphy duties on H.M.S. "Vernon," and in 1910 wireless telegraphy officer attached to the Mediterranean Cruiser squadron. In the following year he became Fleet Wireless Telegraph Officer in the Mediterranean and is the author of the Admiralty Wireless Telegraph Manual, Vol. I, published in 1911. In 1912 he was appointed in charge of the Malta Wireless Telegraph Stations and in 1917 was attached to the Naval Staff of the Admiralty.

Of the Military Members, Lieut.-Colonel Evans is responsible for the Military Wireless Working, and Captain Moorshead represents the Department of Military Intelligence.

Colonel F. L. Blandy, D.S.O., representing the Air Force, is Deputy Director of Communications in the R.A.F., and is responsible for the whole of wire-

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less communications in that arm. Prior to taking up this appointment Colonel Blandy was in charge of the Biggin Hill Experimental Establishment.

Colonel C. P. Grenfell, D.S.O., representing the Air Force, has had a long experience in radiotelegraphy. Before the war he was associated successively with the Eastern Telegraph Company, The De Forest Radio Telegraph Company, The Amalgamated Radio Telegraph Company and The British Radio Telegraph Company. During the war he was in charge of the R.F.C. wireless in Egypt, 1915, was attached to the Senussi Expedition early in 1916, and in the same year served in both Salonica and France, where he remained in charge of wireless on Major-General Sir H. M. Trenchard's staff and later on Major-General Sir J. M. Salmond's staff until June, 1918. Colonel Grenfell was on the staff of the Chief of the Air Staff at the Air Ministry until December, 1918, when he was transferred to command the R.A.F. Wireless Experimental Establishment at Biggin Hill, which command he still holds.

The Wireless Telegraphy Board has no executive power, but its recommendations represent the considered opinion of the Senior W/T Officers of the three services from the purely W/T point of view. The Board exists for the comparison of notes and ideas, the discussion of matters affecting any two or more of the three forces and the prevention of overlapping. In all such matters discussion between representatives of the three forces is of the greatest value, for without co-ordination considerable inconvenience might occur through, for example, stations of the Air Force using the same wavelengths as adjacent naval or military stations. Under the chairmanship of Captain Slee a great deal of highly valuable work has been carried out during the last twelve months and in making the arrangement for peace-time working the Board is still exceedingly active.

The Cape Observatory, South Africa, where a Wireless Installation is fitted for Time Signal Purposes.

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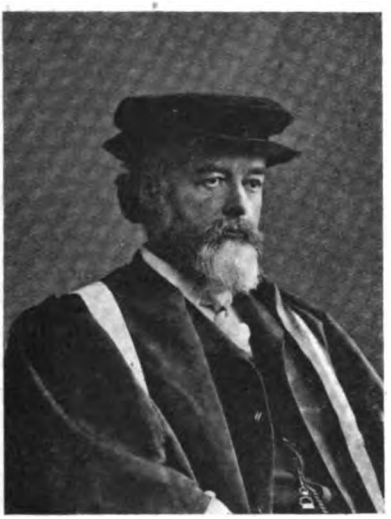
Sir Oliver Lodge's Retirement

Plans for Future Research

AT the close of the present session Sir Oliver Lodge, D. Sc., F. R. S., will relinquish his position as Principal of Birmingham University, a post which he has held since that institution was established nineteen years ago. Luckily for science, however, he does not intend to step from the arena and content himself as a spectator of the wrestling between men and veiled nature; rather does he seek to come to closer grips, to hold on where the grasp of others seems to close upon nothingness, for he announces that the remainder of his life is to be devoted to the physical and psychical problems of the aether. It is pleasant to think that in making this decision at sixty-seven years of age Sir Oliver is instinctively following in the footsteps of the long line of eminent scientists who at sunset were too busy to confess themselves tired.



Sir Oliver Lodge, D.Sc., F.R.S.

Born in 1851 at Penkhull, near Stoke-on-Trent, Sir Oliver Lodge was in 1881 appointed as the first Professor of Physics at the Liverpool University and in 1900 went to Birmingham University as its first principal, receiving his knighthood in 1902 on the occasion of the coronation of King Edward VII. Great as have been his general contributions to physical science and his assistance to and encouragement of scientific thought and education, it is his pioneer work in connection with wireless telegraphy which has won for him a high place amongst the successors of Maxwell and Hertz.

Following a considerable amount of fruitful research on Hertzian waves, in the course of which he improved upon Hertz's apparatus for the investigation of their optical properties, Sir Oliver Lodge was not long behind Senatore Marconi in patenting a system of wireless telegraphy; in this he had the co-operation of Dr. A. Muirhead. The Lodge-Muirhead system is chiefly characterised by the use of a balancing capacity instead of a direct earth connection such as is nowadays generally employed, the wires composing this being arranged in the form of a Maltese cross, a replica of the characteristic flat-topped Lodge-Muirhead antenna. Another outstanding feature of the system is the multiple spark-discharger which, in the case of large power stations, has water-cooled electrodes. The receiving circuit is distinguished by being the first of its kind to be tuned, a natural result of its inventor's earlier work on syntony, whilst the detector, the Lodge-Muirhead wheel coherer, is probably the most efficient form of self-restoring coherer ever evolved. In 1911

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the Lodge patents were acquired by the Marconi Company, one of whose scientific advisers Sir Oliver Lodge subsequently became. Sir Oliver's active interest in psychic research extends, we believe, over a space of thirty years. A significant fact; for when a thinker of his calibre interests himself during three decades in a branch of science which has had thrust upon it the rôle of the poor relation, and then emerges as one of its public champions, there is good cause for those who airily dismiss it as a mere speciality of catchpenny conjurers, to take serious thought.

We venture to wish Sir Oliver Lodge the health and happiness to enjoy his freedom from official duties and a full measure of success in the investigations he is about to undertake—a wish which will be shared by his admirers all over the world.

Birmingham University.

New Commercial Wireless Service

ON March 13th Marconi's Wireless Telegraph Co., Ltd., opened their commercial Spanish wireless service which would have been placed at the disposal of the public in 1914 had not the war made it necessary to use the stations for more important purposes. From this country wireless telegrams may now be sent to all parts of Spain, the Balearic Islands and the Canary Islands, and for this purpose may be handed in at the Company's offices at Marconi House, Strand, or 1A, Fenchurch Street, E.C., besides at any Postal Telegraph Office in the London suburbs or the provinces. The Marconi Company states that on receipt of a telephone request to either of the above addresses, Marconigrams will be collected by their own messengers.

The rate per word to Spain and the Balearics is 2½d., and to the Canaries 4½d., with a minimum of 10d. per message; these rates, taking into consideration the speed and accuracy with which the traffic is handled and the facilities which are offered in respect to the collection of telegrams, should be very attractive to business men.

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Stray Waves

SHOULD WIRELESS TELEGRAPHY BE CONTROLLED?

UNDER this heading the *Electrician* contributes a useful discussion of a subject which, with the cessation of hostilities and the consequent relaxation of certain tentacles of the Defence of the Realm Act, has again sprung into prominence. Unfortunately, however, the article to which we refer is marred by a lapse into what we had hoped was a habit of which the war had cured Britons, namely, that of depreciating our own scientific work and enterprise. For well-known reasons the major part of the work achieved by our countrymen in connection with the development of radiotelegraphic (and telephonic) appliances and methods during the past four years has been a sealed book to the general public and therefore we consider our contemporary's judgment to have been delivered somewhat hastily.

It was not to be expected that the matter could lightly be passed over by anyone representing wireless interests in this country and Mr. Godfrey Isaacs of the Marconi Company has accordingly written to the *Electrician*. We publish without further comment his letter, a copy of which he has handed to us for that purpose:—

The Editor, *The Electrician*.

"DEAR SIR,

"In your issue of the 21st ultimo you publish an interesting article entitled 'Should Wireless Telegraphy be Controlled?' With the views therein expressed most people I think will be inclined to agree. It contains statements however, which are scarcely accurate and unless corrected would probably prejudice British industry at a time when everybody requires the fullest advantage of everything he possesses to keep his end up.

"For instance it is said 'Our National record in Wireless Telegraphy apart from the financial side is a sorry one,' and the writer then proceeds to cite a number of developments which he attributes to different foreign nations.

"The writer of your article loses sight of the following facts:—Wireless Telegraphy at sea was developed entirely from this country. Transatlantic communication was established between this country and the American continent years before anybody else could even attempt it; all the developments abroad of the three electrode valve have been merely developments of, and would not have been possible without, Dr. Fleming's great invention, and its first application to Wireless Telegraphy was by Senatore Marconi in England; and, the continuous wave system which has transmitted messages over the record distance of 12,000 to 13,000 miles is a Marconi machine, developed entirely in this country by Senatore Marconi himself with the assistance of British engineers.

"There have been a great many other developments during the war, but as you are aware they have not been published, and in the interests of the country we have not spoken of them. The writer of your article could therefore have had no knowledge of them.

"Your publication is to our knowledge much read by technicians and others in Foreign Government Departments, and I think you will therefore

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agree that the article in question must be very damaging to us and to the industry of this country.

"I venture to believe that I need only draw your attention to these facts to ensure that in your next issue the credit which is due will be given to British enterprise.

"I am, etc.,

(Signed) "GODFREY C. ISAACS."

FUTURE POSSIBILITIES OF WIRELESS.

No sooner had mankind discovered how to produce and control large electro-magnetic waves when the utilitarian mind began to seek for a means of employing them in the everyday service of the community. In this quest the inventions of Senatore Marconi led the way and we have since seen the application of wireless to telephony, horology, photography, fog-signalling, and the steering of aircraft and seacraft. In his very interesting inaugural address on November 20th, 1918, as Chairman of the Council of the Royal Society of Arts, Mr. Allan A. Campbell Swinton dwelt at some length upon the achievements and possibilities of wireless telegraphy. Referring to the ever-increasing amount of news with which the Wireless Press is providing the newspapers he suggested that there is no reason why printing machines should not be so designed and constructed that they will themselves receive and also print news messages transmitted by special distributing stations. Hence arises a point, which, as Mr. Campbell Swinton indicates, bears directly upon the general aims of the League of Nations, for as it seems impossible to limit the transference of energy by aether-waves within international boundaries, such a news service would of necessity be more or less world-wide. From the point of view of costs, too, there is much in the idea to commend it, since there would be scarcely any limit to the number of news receiving stations which could be served by a single transmitter of appropriate power, and thus the benefits accruing from such a scheme could be extended to private individuals as well as to the daily press.

But by far the most fascinating and important problem spoken of by Mr. Campbell Swinton was that of the wireless distribution of electrical energy in bulk. If, as is likely, electricity is to supersede coal not only in the mine and manufactory but in the home, then sooner or later we must have large power stations feeding much greater areas than those allocated to the present-day stations. From this there arises a problem which may eventually lead us direct to wireless distribution, namely, that of the conductors. This is a matter both of economy and practicability, and emphasizes our need of a material of much higher conductivity than copper and of a cheap insulator which will emerge successfully from the severe test it will be called upon to undergo.

The transmission of high electrical power by means of Hertzian waves is one of the dreams of wireless men and history proves that the dreams of scientists, provided they are the outcome of healthy scientific imaginations, have a way of coming true. The difficulties opposing the realization of this particular dream are numerous and formidable, yet the worst of them, the concentration of the waves upon a given limited area, has been already reconnoitred to some extent by Tesla and the men who are responsible for the systems of directive wireless telegraphy. In any case the idea cannot be dismissed as being outside the bounds of possibility and therefore it is to be hoped that it will not be allowed to drop. Many a promising thing has withered for lack of light and air and for that reason we shall be glad to accord free ventilation to the subject in our pages.

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Notes of the Month

CANTOR LECTURES.

ON February 17th and 24th at the Royal Society of Arts, Dr. J. A. Fleming delivered the last two of a series of three lectures dealing with "The Scientific Problems of Electric Wave Telegraphy." In discussing long distance telegraphy he pointed out that although mathematicians had agreed upon the impossibility of communicating by wireless over half the earth's circumference this had actually been done by the Carnarvon station, as witness its recent feat of reaching Sydney, N.S.W., with good, readable signals. Dr. Fleming devoted considerable time to the problems of the effects upon electro-magnetic waves of the atmosphere and the crust of the earth, mentioning in connection with the latter that in selecting sites for wireless stations engineers would do well to make a geological survey and to determine the dielectric constant and conductivity of the earth in the proposed locality.

The final lecture was given over to a consideration of receiving devices, the history of the three-electrode valve being traced step by step from the first recorded observation of the electrical phenomena of hot filaments to the Fleming valve detector and from thence to the modern valve amplifier. These lectures attracted full audiences on each occasion—the usual tribute to Dr. Fleming's skill and charm as an expositor of science.

OUR DESTINY IN THE AETHER.

From the Toronto *Daily News* comes a strong plea for an Imperial wireless news service. At a time like the present when the units of the Empire are making contact with each other to a degree beyond any before achieved, such a service would be exceedingly valuable. The war has been the cause of a great increase in the production of wireless plant and it should be comparatively easy to find at once sufficient gear to enable a temporary system of news exchange within the Empire to be initiated without much delay. During the past month certain cable routes have been more or less unsatisfactory owing to breaks, and Mr. Godfrey Isaacs, the managing director of Marconi's Wireless Telegraph Co., Ltd., lost no time in pointing out that his Company could step into the breach with a wireless service to Holland within a few hours. The suggestion was eventually acted upon by the Post Office without reference to the Marconi Company. If this can be done in the case of short distances the like applies proportionately to great ones and plainly indicates the desirability of having an aether-line service which will be adequate to handle all the traffic on the occasion of an interruption of the cable service. An old theme, it is true, but although we have awakened to a sense of our destiny in the air, can the same be said of the nation in respect to the aether?

THE BRITISH SCIENTIFIC PRODUCTS EXHIBITION.

One of the more encouraging signs of the times is the announcement that an exhibition illustrative of British scientific invention is to be held next July at the Central Hall, Westminster. The inten-

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tion is to bring manufacturers into touch with inventors, a consummation which should not fail to make for the advancement of British industries. Incidentally there will be revealed many inventions hitherto kept from the public eye by the exigencies of war. As there is to be a section devoted to electrical engineering it is to be hoped that the wonderful developments of radiotelegraphic apparatus will receive fitting attention.

AN UNEXPLAINED PHENOMENON.

From time to time we hear of instances of strong brush discharges taking place from the aerials on ship installations when the transmitter is not in operation. In a case recently brought to our notice the aerial plug was taken from the tuning inductance and laid on a wooden cabinet, when it was found to be emitting sparks, the discharge lasting for several minutes. We are also aware of operators having received severe shocks whilst handling the aerial plug or approaching the hand towards the lower end of the aerial. Having investigated certain similar cases we find that whereas in some of them the discharge occurred whilst the fog-horn was in action and steam was striking the aerial, others cannot be accounted for in this way. Considering that the average ship's aerial is not large it seems that the effect to which we refer cannot be due to any ordinary electrical atmospheric condition of the atmosphere and may result from local super-storms of "strays," in which case it would be interesting to know from what causes such storms arise.

COMMERCIAL WIRELESS SERVICE.

It is announced by Marconi's Wireless Telegraph Co., Ltd., that a resumption of its commercial service to Canada has been authorised by the Government.

The same Company is now accepting traffic for Bermuda, British West Indies and British Guiana.

A Group of Wireless Men of the 7th Army Observation Group.

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Aircraft Wireless Section

Edited by J. J. Honan (late Lieutenant and Instructor, R.A.F.)

Editorial Note : Under this heading we propose month by month to deal with Wireless in Aviation by general articles of an instructional nature, and to give the latest news of progress.

SOME GENERALITIES

DESPITE the enormous strides that have been made during the last few years in the development of aerial navigation, we still stand at the very edge of the new Kingdom.

From there, we peer forth into the future and conjure up prophetic visions of that time to come when the aerial stripling of to-day shall have grown into one huge Universal Transport Service. No longer cramped and distorted into a fearsome weapon of offence, but, instead, grown into its proper heritage of pride and place as perhaps the most powerful and beneficial agency that has yet been conceived of man's genius.

The mastery of the air was consummated in the conquest of the Hun.

In that, to some extent, lies the strength and the weakness of the present position.

During the last four years all progress in the newly-born science of Aviation has been subordinated to a particular purpose—War. Efforts that would normally have been directed and controlled by considerations of commercial efficiency, in tackling the unending difficulties that strew the path of progress, were diverted to the more restricted problem of evolving merely the most powerful weapon of offence.

But, after all, more has been gained than lost. The flow of invention may have been directed into narrower channels; but it has gained pace in the process, and has made headway accordingly. How much, and how quickly, must be left to the judgment of a later period, when all that was done has been made known. Only then will a proper perspective be possible, and a due appreciation be paid to those responsible for the enormous forward strides taken during the period 1914-1918.

CARPE DIEM.

Without the fierce stimulus of war, then, assuredly much ground that is now tilled and cultivated would still be lying fallow.

Now that the Armistice has been signed, and Peace is in sight, let us therefore seize firm hold of this one of the few good legacies of the God of War, and improve and remodel it on standards of general utility, and so give its future a new scope—one more appropriate to the era of peace and to the great part it will play in the good days to come.

THE GENERAL VALUE OF WIRELESS TO THE AVIATOR.

Wireless is the *Fidus Achates* of Aviation. Without it the warrior pilot would have been sadly crippled in his late career. And in his new rôle—be it that of auxiliary to the Postmaster-General, or rival to the great Railway and Steamship Services, or even triple-express agent of Carter Paterson, or Pickford—he will find himself sorely handicapped without the kindly aid of the nimble ether wave.

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Presently the world will be the richer (let us be optimistic!) by the creation of a Board of Aerial Control. It may start in rather a small way, but pilots and all those others (lesser lights, shall we say?) who look forward, one day, to earning their bread in the skies will come, in time, to treat it with that respect—quite untempered by affection—that is paid by the sailor-man to the Mercantile Marine Department of the Board of Trade. There will be many things about which it will frame ponderous and weird regulations, and "aircraft, wireless installations for the use of" will be one of them.

The Mercantile Marine has already set the fashion in wireless for the sailor. The necessity is even greater and more urgent in the case of the airman, so that it behoves such to take time by the forelock, and to mark, learn, and inwardly digest the signs of wireless progress as it is applied to the gentle art of aviation.

DEVELOPMENT OF WIRELESS SETS DURING THE WAR.

Since 1914 many types of telegraphic and telephonic sets have been evolved by the R.N.A.S., the R.F.C., and the R.A.F. for specific use with aircraft. But the brand of war is not marked so deeply on them as upon the craft they serve; in fact most of the service sets are admirably adapted to commercial use.

Up to the present, however, it has not been possible to publish any account of their design or give particulars of their specific use. Indeed it is well known that the Enemy were most anxious to get hold of certain of our instruments, particularly the C.W. sets, and copies of German notices have been found in which big rewards were offered to their troops for the salvage of any portion of such instruments from wrecked planes. In turn we took special precautions to ensure the destruction of such sets as were known to be the particular object of Hun envy—in the event of any of our craft unavoidably falling into their hands.

The time has now come, however, when there is every reason to expect that the curtain of secrecy will be raised and that it will be possible to publish a description of certain specified types. When this is permissible they will be dealt with in some detail in subsequent pages of this section of the WIRELESS WORLD.

HOW WIRELESS GADGETS GENERALLY STRUCK THE AVERAGE PILOT—OR *VICE VERSA*.

In the days of not long ago, the flying man had, in the ordinary way, a somewhat excessive number of things to think about whilst plying his diversified trade amongst the clouds; and wireless gadgets in particular were wont to make him exceedingly tired and even peevish.

However, occasion arose from time to time which indicated that they had their good points. Very useful, for instance, in calling up the drome if Fritz should appear in large quantities whilst one was doing a lone "shoot" or patrol. It was better to make the affair into a pleasant conversazione, when the occasion offered, rather than to endure an unprofitable one-sided interview.

Again there was something to be said for the advantage of being able to go out solo—without observer or wireless operator—and conduct a little "shoot" alone. There was a certain zest added to the game when one could personally send an O.K. from time to time; or metaphorically "blind the gunners' eyes" when a "rank outsider" was recorded.

For this kind of work, a small short-range spark set was used, run from accumulators. There were practically

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no adjustments to be made—just the aerial to be dropped, and a plug to be inserted.

Of course Morse was a bit troublesome, but not too bad, "and a bit of practice soon gave you speed and style" (ask the poor wireless operators in the batteries!). Moreover, once learnt, Morse had some useful applications apart from shop—into which it is not within the scope of this article to enquire.

However, in many cases, the quite understandable, if not wholly reasonable, initial prejudice of the average pilot against wireless was in one way or other broken down, and he became ready to investigate. Once having reached that stage he almost invariably "acquired grace," adopted the W/T instruments into his family of pukka gadgets, and thenceforward considered them as being worth their room in his bus instead of representing so much superfluous "clobber."

WIRELESS *MUST* BE TAKEN INTO ACCOUNT BY THE AIRMAN.

The pilot who thus broke the ice and made friendly acquaintance with his useful ally is going to save himself trouble now should he decide to turn to the commercial side of flying.

For there is one thing just as certain as that the aeroplane has come to stay, and that is that it cannot do without wireless. Wireless telegraphy, wireless telephony, and last, and by no means least, the latest phase "direction finding" or navigation by wireless, will grow in scope of usefulness with the development of aerial traffic generally, until one becomes so much an inherent part of the other that they shall be well and truly married and no man shall put them asunder.

Consider the question from one or two aspects.

What other means will provide rapid and accurate communication with Mother Earth, once it has been left. Signal lamps, flags, smoke bullets—what you will—all are old-fashioned and obsolete. They served their purpose in the early stages; but wireless is the one and only way now. It is the *goods*. And as such it becomes part of the pilot's educational outfit. Otherwise he will become a back number.

It is equally essential for solo flying, and for passenger work. As the flying controls of the aeroplane are steadily simplified, so the capacity of the pilot for auxiliary cares will be increased. And wireless should be the first to be adopted.

SPARK SETS.

A simple spark set working on short wavelengths but with ample range for signalling to control stations and for similar kind of work already exists. It is run from accumulators; is simple to understand, and keep in efficient working order; weighs about 30 lbs. all told; and can be stowed away in an insignificant space. It is so useful within the stated limits that it may be regarded an indispensable part of the average bus equipment.

Then again, a longer range of transmission may be required; and the need has been met by the evolution of various types of continuous-wave valve generators, or small rotating-electrode sets. The former especially combine great efficiency with compactness and lightness. The latter type is heavier and more suitable for use in the bigger craft. Of course, the most suitable installation is entirely dependent upon the precise nature of the flying duties concerned.

The simple type of spark transmitter may be sufficient in the case of short point-to-point trips, whilst an entirely different outfit may be called for by the requirements of long-distance journeys, night flying, etc.

TELEPHONY SETS.

Small telephony sets were developed

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during the war that were practically perfect for the results required. Excellent and clear speech could be attained from plane to plane over a distance of from five to six miles. And this limit was self-imposed for obvious reasons. It was not wise to strive for a longer range in view of the fact that it was mainly evolved for formation-flying and manœuvring, at times in close contact with the enemy. But those limits can be easily passed now that different conditions prevail. From plane to ground the range with same set was much greater.

In these sets, too, simplicity of design was striven for and attained. For transmission, a small generator was employed, fitted on one of the struts and driven by screw blades mounted on the armature shaft and actuated by the slip stream from the main propeller. The armature windings of the generator were so designed as to secure a practically constant voltage throughout the inevitable variations of speed that might be anticipated during a normal flight. A small valve-set generated a continuous wave train, and by means of a microphone speech-frequency variations were imposed upon the steady C.W., so giving rise to audible speech in the receiver. The receiving-set comprised a wonderfully simple two-valve circuit.

Fitted with a double telephony set for reception and transmission, the pilot has full and adequate powers of communication, both with his brother Icarus, or with land. Moreover, with extra pairs of 'phones and a switch he can converse with one or more of his crew or passengers in complete independence of the pandemonium of engine noise that reduces attempts at speech in the higher realms to a mere pantomimic farce.

ONE INSTANCE OF THE VALUE OF A TELEPHONY SET.

Most pilots at one time or other have had the experience of losing a landing-wheel when taking off from bumpy or stony ground.

They retain probably a much clearer recollection of the nasty jar that accompanied the next landing.

In about ten cases to one this kind of mishap is not noticed by the pilot or passenger when it occurs, and that being so the loss generally remains unnoticed until such time as the missing wheel is badly wanted to perform its usual functions on landing. It is then too late, and the subsequent proceedings depend very largely upon the fickle Goddess.

If, however, the pilot *knows* he has lost the wheel, he "acts according," and in landing, manœuvres the joy stick so as to come to ground with a certain loss of grace, perhaps, but without damage to himself or the bus.

But *knowing* makes all the difference.

Should his bus be fitted with a phone set, he will be called up instanter from the drome and informed. The damage is bound to have been noticed there—and in fact is plainly seen by everybody who casts a glance aloft. So that either at the start of his trip or in passage he will be put wise from some land station or other. And to make assurance doubly sure some brother Jehu will inform him *en passant* that his port or starboard wheel is lonely, and will probably beg facetiously for the name and address of the next of kin.

In the old days, failing the phone, there was probably a flurry to get out ground strips—which were never ready in time.

Or a vain attempt to ring up the destination drome, if it was known; even then if the message got through there was sure to be some snag or misfire at the other end.

Or there was an outbreak of fervid and varied signals (not of the wireless variety), which—if noticed at all—only caused the pilot to think pensively of

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the apparent abundance of good liquor that must have been wasted to produce such an unedifying exhibition.

In the last resort another man was given the job of chasing the sinner and attempting to convey the glad news by appropriate and graceful gestures. This was liable to produce many effects upon the unfortunate victim, varying from a contemptuous and complete ignoring of the unseemly performance, to the other extreme of creating a decided vertical draught and causing a sudden swoop to earth to get out of the way of an apparent madman.

If the resultant landing was not too disastrous the mystery was thereupon fully elucidated to the harassed one.

There is no need to embroider the subject. If a pilot has been through a similar experience—or through any of the *contretemps* incidental to his calling —where so much trouble and anxiety or annoyance could have been saved or avoided by the possession of some efficient means of communication with other people, on or off his own bus, he will, as a reasonable man already be a convert to the necessity for installing a telephony set in every type of aircraft.

MORE CONCERNING THE WIRELESS TELEPHONE.

And, moreover, as a servant of science, he should be only too ready and anxious to investigate somewhat, not only the manner of working, but also the inner nature of this marvellous little instrument.

For in a sense it is even a more astounding manifestation of the mastery of mind over matter than even that intricate combination of machinery and structure that represents man's conquest of the air.

It is an interesting speculation as to which achievement would appear the more miraculous could it have been presented, say, to Archimedes—or even for the matter of that to Newton.

At all events the annihilation of space encompassed by the harnessing of the universal ether through the medium of wireless apparatus generally, but more particularly the development of the wireless telephone, represents a feat undreamt of but a few decades ago, whereas the art of flying is an ambition that has burnt in the bosom of man since the mythical days of the ill-fated Icarus.

APPEAL TO A CERTAIN TYPE OF MIND.

There must be an enormous fascination to the youth of scientific imagination in a career that is concerned with both achievements. It will be many a long year before the attraction of flying begins to pall. The world will be getting grey-whiskered in earnest then. And so long as man—of all ages—has not fallen into senility he will feel the call of the high, blue spaces. The old time life afloat will yield premier place, in the days to come, to the fascination of the "life aflight." Add to that the attraction that wireless undoubtedly has for the average scientifically-inclined youth, and the combination offers a future career full of stimulating possibilities.

DIRECTION-FINDING APPARATUS.

It is more particularly in the development of the latest application of radio energy that the widest scope will be offered for a new career.

Direction-finding apparatus will in future form an absolutely essential part of the navigation outfit of all long-distance machines.

Directive transmission has long been a problem for the wireless engineer, but it is due to the inception of an efficient "radiogoniometer" or receiving-device that analyses the direction of the normal to the oncoming ether wave-front (and

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therefore indicates its actual centre or point of origin) that the art of navigating by wireless has become possible.

Such a navigating set would have saved us the loss of that famous early Handley-Page machine that so sadly went astray one foggy day into the joyful hands of the Hun.

But, in revenge, D.F. sets *were* ready installed, perfected and indispensable, in those sleuth-hound craft that were on the point of being loosed to nose their deadly way to Berlin when the Armistice rang down the curtain. Sleuth-hounds, because like those animals they were provided with a faculty that would have guided them unerringly to their goal.

ANOTHER TRIUMPH OF RADIO INGENUITY.

An arrangement of loop aerials hidden away in the fuselage and wing, a cascade set of receiving valves, and a simple differential indicator operated by a throw-over switch. Nothing very intricate or imposing to look at, occupying but little space, making but little demand as regards weight, easy to manipulate, and reliable.

It represents the triumph of the radio engineer, and the full extent of its application has, as yet, hardly been realised.

This set as fitted to the latest bombing machines has not long emerged from the experimental stage. There are still one or two inherent difficulties to be overcome before absolute precision is attained. One arises from the refraction effect or bending of the ether wave front as it encounters air strata of varying "ionic density"—particularly in the case where the transmitting station and receiver are on different sides of the dawn. The action of the sun causes the air to become comparatively more ionized and therefore slightly denser to the passage of the electro-magnetic waves; the wave-front is consequently slightly bent or distorted. But this difficulty is being met and will be overcome and in any case the effect is relatively insignificant.

At present the results are wonderfully accurate—far beyond any alternative method, particularly for night flying, and certainly well within the limits of accuracy required for ordinary long-distance flying.

The set is, of course, being utilized for the transatlantic flight, and amongst the many objects to be served by that long-anticipated trip the successful application of this latest contribution of wireless to the onward progress of aviation will not be the least important.

HOMING BY D.F.

In its simplest application, that of flying directly towards or away from a given transmitting station, only the wing coils are employed, the fusilage coil being cut out. The operation of the set in this manner is practically automatic, and can easily be managed by the pilot of a solo machine. No calculations are required, and no possible error can arise.

NAVIGATING BY D.F.

In steering a definite course (as distinct from "Homing" on to a given station)—or in finding one's bearing in an unknown position, the process is slightly more involved, but it is by no means intricate.

In such cases, however, the presence of a navigating officer or operator is necessary. Bearings are taken from the plane, first on one transmitting station, whose location is identified by means of its code call, and next on a second known station. As the distance between the two transmitting stations is one of the known factors (or can be ascertained from the chart) and as the angle subtended by that base line at the point occupied by the plane has now been ascertained by the direction-finder, the exact determination of the plane's position is a matter of simple trigonometry.

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Aviation Notes

WEATHER PROGNOSTICATION.

THE coming boom in air traffic will mean a lot more work for the long-suffering Clerk of the Weather! The number of observation stations under the control of the Meteorological Office at the commencement of the war proved quite inadequate to give the detailed and reliable information as to weather conditions required for the guidance of pilots in the various theatres of war.

To fill this want the Royal Air Service created a new department of "weather prognostication," and erected a large number of additional wireless stations, scattered far and wide for the sole purpose of observing and recording data necessary to compile those weather forecasts which so often made the difference between life and death to the flying man.

MR. GRAHAME-WHITE'S LATEST AEROBUS PLANE.

In a recent address to the Royal Aeronautical Society, Mr. Grahame-White gave some interesting particulars of a machine he is designing for the London-Paris Service.

It is a biplane planned to carry 24 passengers exclusive of the crew and fitted with three 600 H.P. motors, two being tractors and the third a "pusher."

It is specially interesting to note that of the crew of five, one is a navigating officer and a second the *direction-finding wireless operator.* Verb, sap!

OBIT.

Lieut. E. H. Dimmock, R.A.F., of the Wireless Telephony School, Winton, Bournemouth, died on February 3rd of pneumonia.

A Group of Telephony Officers, R.A.F. Wireless School, Farnborough.

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Practical Notes on the Use of Small-Power Continuous Wave Sets

BY J. SCOTT-TAGGART, M.S.BELGE E., A.M.I.RADIO E.

I. TRANSMISSION.

THE following notes are intended to show the value and possibilities of the continuous-wave set for communication purposes, and to deal with some of the practical points of interest to those whose experience in this direction is limited.

The simplicity with which undamped oscillations may be produced by means of the vacuum valve has opened up a new and extremely interesting field, which includes wireless telephony, to those whose opportunities were previously confined to the working of spark sets. It is of particular interest to the experimenter on account of the opportunities for investigation of a subject which is comparatively in an embryo stage.

Continuous-wave wireless, until recently, was often regarded as the privileged monopoly of those who had facilities for producing oscillating arcs by means of high-voltage currents. At the present time, however, the transmission of messages by means of undamped waves is of practical interest to all, and is no longer restricted to the fortunate few. Moreover, the expense of working continuous-wave wireless sets is, if anything, less than that of spark sets.

Let us first briefly review some of the peculiarities and advantages of this form of communication. The ionic valve can be made to generate persistent oscillations, of regular and almost pure sinoidal wave-form, which set up continuous waves capable of travelling very considerable distances with small loss of energy, and with a small expenditure of primary current. A 10-watt set, for example, can be read at a distance of 50 miles on an ordinary single-valve heterodyning receiver. This fact alone will appeal to those who have no practical knowledge of these sets. On the other hand, this is liable to be considered a disadvantage in that mutual interference between sets is more probable. In spite of this, however, a greater number of stations are able to work within a given area without causing "jamming," partly on account of the sharper tuning of the waves, but chiefly on account of the very high selectivity of the heterodyning valve as a receiver of undamped waves. Let us suppose that such a receiving circuit is tuned to a wave-length of 800 metres, and is therefore oscillating at a frequency of 375,000. If the set now comes under the influence of a C.W. transmitting station sending on a wave-length of 750 metres, these oscillations of 400,000 frequency will interfere with the local oscillation producing beats of 25,000 frequency.

These beats, however, will be quite inaudible to the operator, the human ear being unaffected by frequencies higher than about 14,000. Only when the wave-length of an outside station is between 780 and 820 metres, will its signals be heard by an operator working on a set tuned to 800 metres. This alone

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explains the selectivity of continuous-wave working. Moreover, it explains why for practical purposes it is necessary to work on wave-lengths of the order of 1,000 metres. If a wave-length of 300 metres were used, and the receiving set were tuned to a wave-length more than three metres to either side of the correct one, no signals would be received. The arrangement, therefore, would be excessively sensitive and the swinging of the aerial or the slightest movement of the operator would cause the pitch of the note to vary, and would probably cut it out altogether at times.

Another point in connection with small-power C.W. sets is that the note-frequency can be varied at will on the receiving instrument by slightly altering the tuning of the local circuits. There is, therefore, no means of distinguishing a station by its peculiar note, as is the case in spark wireless. There is, however, the advantage that perfectly clear high notes may be obtained which can be easily read through atmospherics.

Distinctive notes *may* be given to stations by sacrificing the uniformity of the stream of waves, by making the voltage applied to the plate of the valve of an irregular or intermittent nature.

The waves emitted, however, cannot be strictly considered "continuous," and are capable of being received to a certain extent on ordinary circuits used for spark reception.

A further advantage of continuous-wave communication is that much looser couplings may be employed than in the case of undamped waves. The application of this fact is discussed later.

A commercial advantage of C.W. work is that a much higher speed of transmission is possible than in the case of damped waves where, if the speed of transmission were high, only one or two wave-trains would be sent to a dot or dash.

On account of the present desirability of secrecy, it is impossible, just yet, to give details of the more recent developments of this branch of wireless telegraphy. The diagrams given here, however, are of circuits already well known, and which, while giving excellent results themselves, have been the basis for improvements in design.

Although a set may easily be designed having circuits which may be used for transmitting and receiving, it is preferable to have two sets, one a receiver and the other a transmitter. No alteration of adjustments need then be made, and each set may be adjusted to those values of reactance, filament current, high-tension voltage, etc., which give the best results. Owing to the very fine tuning required, it is highly undesirable that adjustments which affect wave-lengths should be altered when once they have been fixed.

Fig. 1 shows a typical circuit for the transmission of continuous waves. It consists of two oscillatory circuits, one forming the grid circuit and the other being included in the plate circuit of a valve. The plate oscillatory circuit also forms part of the open radiating circuit, auto-transformer effects being thus utilised. This direct type of coupling is perfectly efficient for continuous-wave work, and there is practically no advantage in having a separate open aerial circuit.

The grid oscillatory circuit may be made either variable or aperiodic. Slightly better results are obtained by tuning both plate and grid oscillatory circuits to the same wave-length. On the other hand, an aperiodic grid circuit lessens the number of adjustments necessary, and is perfectly efficient provided the discrepancy in wave-length between plate and grid circuit is not too great.

R is shown as an aperiodic reaction coil of such dimensions as will give a wave-length approximating to the one it is proposed to use. The coupling between

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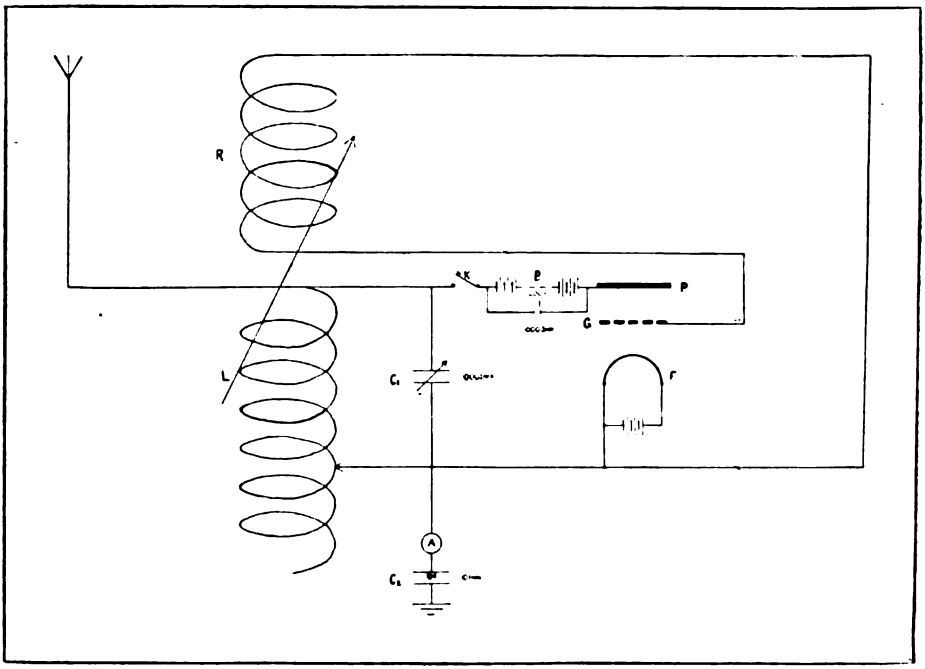

Fig. 1.

R and L is variable. C_1 is a small variable condenser of .005 mfd. for obtaining a fine adjustment of wave-length. A is a hot-wire ammeter for measuring the aerial current, and should read up to about 300 milliamperes. F, the filament of the valve, is heated by means of a six-volt accumulator. B is a high-tension battery of about 400 volts, consisting of a number of dry cells in series. It is shunted by a blocking condenser, which allows a more ready passage for the high-frequency oscillations taking place in the plate circuit. K is a tapping key. C_2 is a blocking condenser in series with the earth, and is found to improve the results obtained. The best value for its capacity is determined by the capacity of the aerial. A value of .01 mfd. has been found suitable.

The above arrangement enables the reaction coil R to maintain the oscillations in L during the time that the key K is depressed. The frequency of the continuous waves emitted depends upon the values of the inductance L, the condenser C_1, and to a smaller extent, on the value of the coupling between L and R. The value of the aerial current measured by A depends upon the coupling between R and L, the choice of values of L and C_1, the dimensions of the aerial, and chiefly the plate current (which is itself dependent on the plate voltage, the filament current and the nature of the valve).

Let us deal separately with the above facts.

In C.W. work, as in spark wireless, the longer and higher the aerial the greater will be the range of the set. The advantage of a long high aerial is, however, not nearly so marked in the case of C.W. sets. They are capable of transmitting, and more particularly receiving, long distances on short low aerials. Thus an aerial about ten yards long and three feet high will enable communication to be carried on over a distance of five or more

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miles. Moreover, it is fortunately an easy matter to make these small aerials radiate efficiently waves perhaps twenty times as long as the natural wave-length of the aerial. There is, however, for each aerial a wave-length on which maximum radiation is obtained, and this can be found by trying different combinations of L and C. For receiving continuous waves it is quite unnecessary to have the same height of aerial. If the aerial is too high, it is liable to give rise to excessive interference from spark stations, whose signals are improved to a greater extent than those from continuous-wave stations by increasing the height of the aerial. The best arrangement in some cases is therefore to have a high aerial for transmitting and a low one for receiving. It will be found that although the receiving circuit is made to oscillate very strongly when the other aerial is being used for transmission, this interferes in no way with the strength of signals obtained at the distant receiving station. When using very small aerials for transmission, their capacity should be made large. This may be done by having a large number of wires, or, more simply, by using a length of wire netting or gauze. Such aerials have been used by the writer with great success on motor-cars, railway wagons, etc., while moving, over ranges exceeding ten miles.

In addition to ordinary aerials, ground antennæ will be found to give excellent results, particularly when receiving signals. A suitable arrangement consists of two insulated wires, well insulated at the ends and about 80 yards each in length, raised a little from the ground, if possible, by grass or undergrowth. The lines should be run out from the aerial and earth terminals of the set, and should point in the direction of the station to which it is desired to work. Very decided directional effects will be noticed. Interesting results may be obtained by earthing the ends of the antennæ direct or through condensers. When using such aerials, the condenser C_2 should be small, and when receiving, greater values of high-tension voltage will be required to make the circuits oscillate.

On depressing the key K of Fig. 1 the system commences to oscillate, and a reading of perhaps 150 milliamperes will be registered by the ammeter A. The coupling between R and L is adjusted until the maximum reading is obtained in A. If the coupling is too loose, the alternating voltages on the grid of the valve are not sufficiently high to cause large changes in the plate current of the valve. This plate current is normally something like 40 milliamperes, an alternating voltage of about 50 volts being required to vary this current between zero and 80 milliamperes. If, on the other hand, the coupling is too tight, the voltage induced in the grid oscillatory circuit is greater than is necessary, and considerable energy is wasted in maintaining these undesirably strong oscillations. In addition, too tight a coupling impairs the wave-form of the oscillations, and harmonics are very liable to be produced.

Not only should the reading of the ammeter be high when the reaction coil coupling is correctly adjusted, but there should be no wavering of the needle when signals are being sent. This occasionally happens through the valve hesitating to oscillate. At the receiving station this results in broken signals. Another reason for the wavering of the ammeter needle, and a more likely one, is the unsuitability of the valve. Some valves give infinitely better results than other specimens of the same type. The vacuum requires to be of a very high order for transmission, and, if not good enough, will lead to irregularities in the movement of the ammeter needle. At the same time, excessive dimming of the

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light from the valve is noticed when the key is pressed, and if the valve is genuinely "soft," a bluish glow will be seen. Valves should therefore be tested on the transmitting set, and those which fail to give a good ammeter reading, or which give an irregular one when the key is depressed, should be used on receiving circuits only, where they generally give better results than harder valves.

In place of the ammeter A, a small flash-lamp bulb may be included in the earth lead, the brightness of the light from the bulb indicating the relative strength of the aerial current. If the ammeter ever goes out of working order it may be shorted and the small lamp connected up as described.

A diminution of the filament current will cause a very appreciable difference in the aerial reading, and the accumulator should therefore be kept fully charged. The high-tension battery also should be seen to if the ammeter reading is below normal. Its voltage should be tested in sections when on load, and not after the battery has been standing for some time, as otherwise an excessively high value will be obtained which immediately drops after a few minutes' transmission. When the voltage of the 400-volt battery drops to about 350 volts, it should be replaced and tested through, and new cells substituted for the faulty ones.

In order to obtain the best radiation from the set the value of the condenser C_1 should be as small as possible. It is quite probable that the same wave-length may be obtained by different combinations of inductance and capacity, and it will be found that the highest readings in A are obtained when an adjustment using a low value of C_1 is made. The use of the variable condenser is therefore merely to give finer tuning.

It may be as well here to point out the great importance which should be attached to the insulation of the aerial, the various windings and connections of the set, the high-tension battery, and even the six-volt accumulator. Everything as far as possible should be mounted on insulators and protected from moisture, which is often fatal to continuous-wave sets.

The lead-in from the aerial should not, if possible, be close to where people are likely to enter. The momentary extra capacity given to the aerial by a person moving about near to the aerial, the lead-in, or even the instrument, is liable to alter the wave-length emitted and to cause signals of varying pitch to be received at the far station. For a similar reason the earth lead should preferably be of insulated wire if it is liable to make contact anywhere. These precautions, though less necessary when dealing with damped waves, are obviously essential when it is remembered that the slightest alteration of the wave-length of transmitted signals results in an alternation of the note received at the other end. For a similar reason the same precautions should be taken at that station also.

It has already been stated that, for practical work, a wave-length in the neighbourhood of 1,000 metres should be used. It has also been shown that the slightest error in tuning at the receiving station will result in no signals being heard. It is, therefore, of the greatest importance that one should be able to tune the transmitter very exactly to the wave-length on which it is desired to send.

An ordinary wave-meter is useless for this purpose. Clicks only will be heard, and only very rough results may be obtained by tuning the wave-meter to the adjustment which gives the loudest clicks.

(To be continued in May number.)

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Correspondence

THE AMATEUR POSITION.

DEAR SIR,

I was interested in "The Amateur Position," written for the March issue of the WIRELESS WORLD, and especially in the support given by such eminent scientists as Senatore Marconi, and Drs. Fleming and Eccles.

I imagine the greatest argument against the use of wireless by private experimenters will be that of interference and I would suggest membership of an accredited Society for Wireless Study should be insisted on before licenses are granted, to prevent, as far as possible, amateurs collecting loose and scattered units of apparatus, and fitting them up under varying conditions of efficiency, for the sole purpose of satisfying curiosity—that is, curiosity in reading commercial messages, for instance. I have known one or two amateurs whose interest in the Science seemed to go so far and no further.

This class, of amateur, of course, does more harm than good to the *bonâ fide* experimenter, who uses his apparatus for the research of radiotelegraphy as a science.

Undoubtedly, such a complex science can only be developed to its fullest extent if willing enthusiasts who voluntarily put their energy to its advancement are allowed to add their efforts to the inventions of others professionally engaged in diligent research.

Perhaps, through the WIRELESS WORLD, an appeal will be suggested for presentation to the Post Office, to inquire under what conditions and when the licenses for experimental work will be returned to former holders.

No doubt if an appeal, signed by, or supported by, some of the well-known experimenters, were to be sent forward this would have the desired effect of eliciting definite information, which at present, individuals, including myself, have been unable to obtain.

Yours, etc.,
(Signed) J. KENNETH HELE.

The Editor, WIRELESS WORLD, Strand, W.C.2.

DEAR SIR,

RE AMATEUR WIRELESS.

As the oldest holder of an Experimental wireless license in this district, I was greatly interested in your article in your March number as to the position of the amateur.

As it seems "interference" is to be the platform on which the private experimenter is to be "suppressed" might I suggest the two following regulations which should stop all interference with commercial wireless.

1. The wavelength radiated not to exceed 200 metres.

2. That all transmitting sets are to work with an efficient break-in system.

No. 1 works very well in U.S.A. where in the past every encouragement has been given, and as 600 metres is the commercial wavelength, it would be a very poor operator who could not tune out 200 metres waves. No. 2, of course, enables the operator to at once hear if any other station is transmitting.

Thanking you for the keen interest you have always shown for the amateur,

Yours faithfully,
(Signed) W. A. PELLY.

SIR,

Apropos to your articles on pp. 667 to 671 and your footnote in reference to a copy of a letter inserted in "The Portsmouth Evening News" which you display on page 683, I enclose herewith a letter received by the writer from the G.P.O. being a reply to the writer's enquiry regarding the question of amateur-owned W/T stations after peace is signed.

You will observe from the communication in question that the question is under official consideration, and the writer thinks that an announcement in your valuable magazine may do much to allay fears and suspicions cherished by many amateur enthusiasts, among whom the writer is proud to number himself.

I would further enquire whether you would be kind enough to insert a paragraph requesting amateurs in S.E. Essex to communicate with the writer with a view to the formation of a club when our aspirations in regard to the pre-war conditions of amateur W/T are likely to materialise.

Thanking you in anticipation of your courtesy and with every wish for the continued success of your welcome monthly.

Yours, etc.,
ALEXIS J. HALL,
Ex Wireless Experimental Officer, R.A.F.
General Post Office,
London, E.C.1.

SIR, *16th December*, 1918.

WIRELESS TELEGRAPH APPARATUS.

With reference to your letter of the 10th instant addressed to the Engineer-in-Chief of the Post Office, I am directed by the Postmaster-General to inform you that the conditions under which the use of wireless telegraph apparatus for private purposes can be permitted when the Defence of the Realm Regulations cease to be in force are under consideration, and a further letter on the subject shall be sent to you as early as possible.

I am, etc.,
(Signed) M. D. WARD.

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The Editor, WIRELESS WORLD.

DEAR SIR,

If the Government are contemplating a decision to grant no renewals of licences for the non-professional W/T enthusiast on the ground of possible interference with Government stations, I would venture to suggest that providing an amateur can show his capabilities to operate a station to conform with the existing Wireless Regulations, he should be granted a licence.

The fact that several enthusiasts in the field of wireless have spent considerable sums of money on their apparatus is sufficient testimony to the fact that they would not endanger the possibility of forfeiting their licences for the sake of annoying other stations.

The P.M.G. could at least grant a "probationary licence" and if any amateur was found to be contravening the regulations, let the licence be suspended for such periods according to the gravity of the offence committed.

Any further recurrence of the offence would warrant the complete forfeiture of the licence. I think this would meet with the approval of the majority of amateurs in the country who are keenly desirous of continuing their experiments in this highly interesting field of science.

I am, Sir,

Yours faithfully,

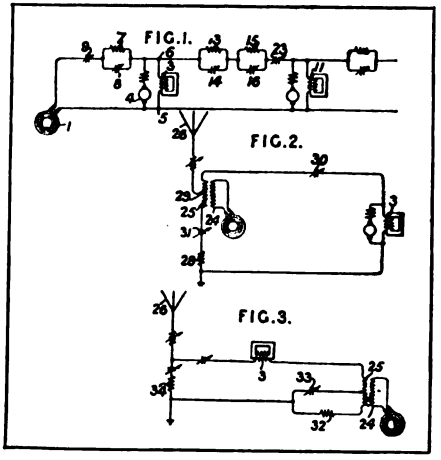
"STATICA."

Patent Section

Under this heading will be printed each month abridgements from the Illustrated Official Journal (Patents) of wireless patents recently published.

121,500. Changing frequency of alternating-currents. British Thomson-Houston Co., 83, Cannon Street, London. (General Electric Co., Schenectady, New York, U.S.A.) November 14th, 1917. No. 16717. (Classes 38 (ii) and 40 (v).

An arrangement for increasing the frequency of an alternating-current consists of a source of alternating-current connected to a circuit provided with means for distorting the wave form of the current, thereby obtaining currents harmonic to the fundamental current, and a second circuit connected to the first circuit and resonant to the desired harmonic frequency. A third circuit similar to the second is provided if a further increase of frequency is desired. The first circuit is provided with means for stopping currents of the harmonic frequency, while the second circuit is provided with means for stopping currents of the fundamental frequency. When applied to wireless telegraphy, the aerial connexion is such that the aerial currents have no action upon the frequency changing circuit. In the arrangement shown in Fig. 1 an alternator 1 is connected to a circuit containing a tuning condenser 9 and a wave-deformer consisting of an inductance 3 partly energized by a direct-current source 4. The terminals 5, 6 of this circuit are connected to a similar circuit containing a tuning condenser 23 and an inductance 11. The first circuit is provided with a circuit 7, 8 tuned to the frequency of the second circuit, thereby preventing the currents of the second circuit from passing into the first circuit. The second circuit is provided with a circuit 13, 14 tuned to the frequency of the first circuit and with a circuit 15, 16 tuned to the frequency of the succeeding circuit, whereby currents of the frequencies of these circuits cannot pass into the second circuit. In the arrangement shown in Fig. 2, the first circuit containing tuning capacities 30, 31 a wave-deformer consisting of an inductance 3, and an inductance 28, is coupled to the generator 1 through a transformer 24, 25; while the load circuit consisting of an aerial 26 is connected to an intermediate point 29 in the secondary winding 25. The inductance 28 and the capacity of the aerial operates as a device for preventing the higher frequency current from flowing in the circuit containing the capacities 30, 31 and the inductance 3, while the intermediate connexion 29 prevents the high frequency currents from flowing in the alternator circuit. In the modification shown in Fig. 3, a circuit 32, 33 is tuned to a lower harmonic frequency, say the third harmonic, and a circuit consisting of an inductance 34 and the aerial capacity to the ninth and desired harmonic.



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The Construction of Amateur Wireless Apparatus

In this, the first of a new series of Articles designed to give practical instruction in the manufacture of amateur installations and apparatus, the author deals with the main considerations in the design of a station. Subsequent Articles will explain in detail how each piece of apparatus may be constructed. The Wireless Press, Ltd., has arranged with Marconi's Wireless Telegraph Co., Ltd., to supply complete apparatus to the designs here given as soon as Amateur restrictions are released.

Article One : GENERAL CONSIDERATIONS.

THE wireless amateur who has taken up the study of his hobby, either by attending classes, or by reading some of the excellent books published on the theory of the subject, finds himself in a quandary when he commences to apply his theoretical knowledge to the actual construction and working of a station. Information as to the design of apparatus, on modern lines, is surprisingly scarce; and design, in wireless work, is the critical factor which will decide whether the apparatus shall operate with maximum efficiency or result in complete failure. For example, in a receiving circuit, an incorrect jigger ratio will render valueless all the amateur's endeavours to obtain the highest aerial he possibly can.

Recent developments in wireless telegraphy, more particularly in connection with the three-electrode valve, open up an entirely new field of work. The valve is peculiarly suited to the amateur's requirements. It may be used both for receiving and transmitting, and the man who possesses a good valve receiving circuit, even though he only has a very small aerial, will find himself far ahead of his friends using crystal receivers, though they may be favoured by being able to erect high and costly aerials. The construction of the valve itself will not be dealt with, as it is beyond the reach of the average experimenter. Expert glass blowing is required and special exhausting pumps capable of producing very high vacua. The valves can be purchased, and the cost is not high. Every amateur is strongly recommended to take up the study of valve theory, the subject is a rapidly expanding one and as yet the field has only been partly explored. There is ample opportunity for the amateur to give valuable contributions to our knowledge of the three-electrode valve. The circuit arrangements and methods of application are legion, one has only to consult a file of patent specifications to realise this, and every wireless man has the opportunity of increasing the store of information. It will be quite impossible, in the scope of these articles, to deal with the subject exhaustively. We shall content ourselves with the design of apparatus employing the valve in two or three typical ways.

In regard to transmitting apparatus. The spark system will no doubt retain many adherents; but continuous wave transmission has so many advantages from the amateur's point of view, that

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we propose to deal with transmitters of this type in some detail. This branch of the subject will doubtless be new to many, and can therefore be approached with added interest. For communication over long distances with small transmitting power it is the ideal method. Actual communication has been established between two stations five hundred miles apart, with quite small aerials, using a power of only *ten watts* in the transmitting aerial. This result may appear incredible to many and will serve to illustrate the possibilities of the system for the amateur. A continuous wave transmitter, more especially of the valve type, is very readily adaptable for wireless telephony, and we shall give designs for the construction of such apparatus. This latter development is of particular interest. There is always a mysterious fascination in conducting a conversation with a friend miles away, and hearing and identifying his voice, with no tangible connection between the two places.

At the outset, we wish the amateur to understand that these articles will *not* give instruction in the theory of wireless telegraphy. There are many books on the topic and it will be assumed that the reader has a thorough grasp of the essentials of the subject as set out in "The Elementary Principles of Wireless Telegraphy," by R. D. Bangay, in the last edition, both Parts I and II. It is absolutely necessary that the wireless man should understand the elements of alternating current theory and its extension to oscillatory circuits and high frequency currents. There is nothing to alarm the reader in this, once get rid of the idea that there is something mysterious and intangible about a high frequency current and difficulties vanish. There is no fundamental difference between the ordinary alternating currents used for lighting and power and those used for wireless, save that of frequency.

There is one other point to which we will refer before going on to practical considerations—namely, that of the amateur's licence. Every experimenter must obtain a licence before he commences work in wireless telegraphy. It is very necessary that the State should control the operations of wireless stations in order that public and commercial communications may proceed without interference. We urge upon every person who takes up wireless telegraphy either as a hobby or for serious experimental work, to take the greatest care to carry out their work so that the limitations set out in the licence granted to them are in no wise exceeded. The genuine amateur wireless telegraphist, will, of course do his best to observe the regulations in spirit and in letter, but it is very easy to make mistakes. Unless one is careful in checking the wavelength being used for transmitting, one may be unknowingly interfering with some other station engaged in important public work. It is the duty of the amateur, in return for facilities offered by the State, to take the greatest care in his work. Carelessness in this respect can only result in restrictions being placed upon amateur wireless. Another important point is secrecy, it is essential that private messages which may be overheard should not be divulged. Comment on this is unnecessary. It is, of course, not possible at this juncture to give any information as to what regulations the Government will apply to private wireless stations, but as soon as the rules are issued a full announcement will be made in these pages for the guidance of amateurs. Readers will understand that until this information is available we cannot go into the fullest details with regard to apparatus, as much depends upon the limitations of power, wavelength and system which may be ordered. We shall therefore, for the time being content ourselves with the indication of

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the general broad principles which the constructor should follow when considering the erection of a station.

Amateur wireless telegraphists can, in the main, be divided into two classes: (*a*) the man with a natural inclination towards electrical engineering, whose hobby is his station; and (*b*) the man who wishes to experiment in wireless telegraphy from a purely scientific and academical standpoint. The first class form much the greater part of the body of wireless amateurs, and these articles will be therefore more particularly designed for the guidance of that class, but we hope to make them of such a character that the purely scientific student will find the practical assistance, and the designs given, of value to him in his work.

One of the first things to be considered is the site for the proposed station. The ideal transmitting or receiving aerial would be one erected upon a perfectly conducting surface. This ideal condition is, of course, not realisable in practice. The nearest approach to be made to it is that of an aerial on a steel ship at sea. In this case the "earth" is formed by a connection made to the hull of the ship; and since the hull is in contact with the surrounding sea water, which is a comparatively good conductor, we do arrive at a condition similar to the ideal. The opposite extreme is that of an aerial above a perfectly insulating surface, the "earth" in this case being formed by wires stretched out under the aerial. This condition is neared in the case of a station erected on dry desert sand. An aerial of given height operating under these conditions cannot be as good a radiator as a similar aerial erected under the first-mentioned condition, unless the earth wire system be very extensive. The site of the average station will lie somewhere between these two cases, and it is safest in practice to aim at getting as near to the first condition as is possible.

In a country site the main points to be observed are:—

(1) Choose preferably high ground, and if near to the coast it will be better to choose land which slopes away towards the sea.

(2) The space around the station should be as open as possible, trees, etc., do not matter as long as not too numerous and not too close to the station.

(3) The ground should be such that it does not become very dry and scorched during the summer. Extensive earth systems are needed on land of this kind. It has been stated that a station should be erected over water-bearing strata which lead to the sea. Refinements of this kind in site choosing are generally impracticable.

The three points given above can only be observed in certain cases, a large number of wireless amateurs live in towns and are compelled to make the best of circumstances which exist.

In a town site the main points are:—

(1) Try to get the aerial as high as possible. By "height" in this case is meant the distance of the aerial above the surrounding buildings and neighbouring conductors. An aerial supported ten feet above the leaded roofs of a building 50 feet in height cannot be taken as having a height of 60 feet. The presence of conductors under or near to the aerial effects a considerable reduction of effective height.

(2) Avoid running the aerial close to and parallel with telephone and telegraph wires. This is particularly important in the case of a transmitting aerial. Currents will be induced in the neighbouring wires when transmitting, and if the aerial is within a foot or two of them damage may be done. In the case of a receiving aerial, nearby telegraph wires often cause troublesome "induction"

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noises in the telephone receivers, which may be loud enough to jam out even strong signals.

(3) It is bad practice to bring the aerial down lead close to rain water pipes, etc. Eddy currents are induced in masses of metal close to the down leads. These currents result in losses and reduce the radiation from the aerial.

(4) *Never* under any circumstances use a connection to the gas pipes as an earth. If it is not practicable to sink a special earth plate for the station, connection should be made to the *water* pipe as near as possible to the point where it emerges from the ground.

It will be understood that the above remarks, both for town and country stations apply with much greater force to a station from which it is intended to transmit. Quite good receiving work can be carried out under conditions which appear to be most adverse, and the amateur should not be discouraged because he is not able to arrange his station as well as might be wished. Make the best of the facilities which offer themselves.

The construction of the aerial itself will be governed by whether it is intended to do receiving work only or not. For receiving only a single wire of not too small a gauge is all that is necessary. The increase in strength of signals which is obtained by the use of multiple wire aerials is so insignificant as to render unjustifiable the extra outlay on the aerial. A single wire aerial of No. 14 or No. 18 bare hard drawn copper wire is very suitable. The chief disadvantage being the low tensile strength of copper. This latter limitation makes it impossible to avoid a large sag in a long horizontal part of the aerial owing to the stretching, and ultimate breaking, of the wire as it is tightened up. The aerial is also easily carried away during a gale or blizzard. For this reason it is generally customary to use a bronze alloy (such as silicon-bronze or phosphor-bronze) of high tensile strength for aerial construction. These wires are best stranded, and a very suitable size is 7/19 (*i.e.*, seven strands of No. 19 S.W.G. bronze wires laid together). This special aerial wire is now a commercial article, and the amateur is recommended to start right at the beginning and avail himself of it.

It is not always possible to arrange a transmitting aerial so that there are no joints in the wire, but this can be done in the case of a single wire receiving aerial. By adhering to the rule "no joints" a host of troubles are avoided. The aerial wire outside the wireless room should be one continuous length, and it should be led straight indoors, through a suitable leading-in insulator, right down to the bench or table where work is done. By this principle of avoiding joints anywhere one can at once say with certainty that there is no bad contact in the aerial itself in case of failure of signals, and the tracing of faults is thereby simplified. Joints may have quite a considerable resistance unless carefully made; they also weaken the wire at and near the junction, particularly if the wire is overheated when soldering. If joints *must* be made in the aerial wire, the simplest junction is made by the "Britannia" joint. This joint is particularly suited to stranded wire such as we recommend, and will be explained by diagrams when we give sample designs for masts and aerials. In any case all joints should be soldered up solid. The resistance of an unsoldered joint gradually increases as weathering and consequent oxidation of the surface of the conductor occurs.

It is sometimes stated that enamelled wire should be used for aerial work. The reason given being that uncovered wire oxidises on the surface; this oxidation increasing the skin resistance of the

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conductor. Since the high frequency current in the aerial is at its greatest density on the surface of the wire, it is alleged that this oxidation increases the effective resistance of the aerial as a whole. If any such effect does occur its magnitude is so small as to be quite unappreciable under practical conditions.

Whilst on the subject of joints we would once again warn the amateur that the greatest care should be exercised in the soldering of phosphor- or silicon-bronze conductors. They should *not* be sweated. That is, soldered by coating with flux and then holding in the flame of a blowlamp whilst applying a stick of solder. This method is almost certain to lead to overheating with a consequent reduction in tensile strength of the wire at the point heated. The solder should be carefully applied by means of a copper soldering bit, with the minimum heat necessary. Of course, sufficient heat must be applied to cause the solder to flow properly and permeate right to the centre of the joint. It is not necessary to use resin as flux when soldering outside joints. The continual exposure of a joint to rain soon washes away all traces of any corrosive flux which may have been used. Any flux having zinc chloride as a base is quite suitable.

The earth connection is one of the factors in the usual amateur station which leaves much to be desired. For receiving work, particularly when using three-electrode valve circuits, the quality of the station earth is not important. The regenerative principle which is employed in the majority of circuits negatives any resistance which may be introduced into the aerial system by a poor earth. Therefore it is sufficient, in the case of a town station, to take a lead down to the water pipes. The connection to the pipe should be soldered, and it should be borne in mind that the remarks we have made regarding the necessity of ensuring good electrical joints in the aerial apply with equal force to the earth lead and its connection to the grounding system. In the case of a country receiving station, it will generally be sufficient if a metal plate, about three feet by two feet in size, be buried so that its top edge (*i.e.*, one of the longer sides) is one foot below the surface of the ground. The earth lead, preferably of copper wire, should be soldered along the top edge of the plate, and to guard against the wire becoming detached by corrosion it is as well to insert two or three copper rivets along the edge, taking a turn around the head of each rivet before they are hammered up. It is best to bury the earth plate as near as possible to the receiving room, in order that the length of the earth lead may be kept short. If the lead *must* be long, say over ten feet, it is advisable to insulate it. This may be done either by supporting the bare conductor on small reel insulators fixed to the wall of the building, or by using insulated wire for the lead itself.

In a transmitting station every effort should be made to secure the best earth possible. By "best earth" is meant an earth connection with the lowest resistance possible. The resistance of an earth connection when used for purposes of wireless telegraphy is not necessarily the same as the ohmic resistance when measured by a method employing direct current. In this latter case the resistance measured is that of the earth plates, etc., to the surrounding soil (this quantity is generally known simply as the "ohmic resistance" of the earth connection), and is determined by the contact resistance between the earth plate or plates and the soil. When, however, high frequency currents are used for the measurement of the resistance quite a different value will be found (this value is generally known as the "high frequency resistance" of the earth). In the high frequency resistance of an earth capacity effects

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play an important part; this fact is well illustrated in the use of " earth nets " for portable stations. An earth net consists of a length of copper netting laid on the surface of the ground underneath the aerial. Quite a practical earth can be secured in this manner. We shall return to the question of earth resistance later and indicate the method of measuring both the ohmic and the high frequency resistance of an earth and aerial system.

In a transmitting station it is our object to reduce the resistance of the earth to as low a value as possible. A high earth resistance means that most of the power which is delivered by the transmitter to the aerial is lost. The earth which the amateur will employ is chiefly dependent upon the depth of his pocket. The best arrangement is to lay down a circle of plates, about fifteen feet in diameter, either right round the transmitting room, or close to it. A lead should be attached to each plate and brought to the centre of the circle. All the leads are then soldered together and the earth lead proper jointed to them and led into the transmitting room. The leads from each individual plate is buried in a narrow trench about six inches below the surface of the ground. Each individual plate should be about three feet by two feet and should be buried in the manner indicated for a receiving station. The plates should be close together, edge to edge in fact. The earth may be still further improved by running four or five wires in separate trenches about six inches deep and three feet apart out underneath the aerial and a little beyond its end. It will be understood that in the foregoing description we have indicated the best arrangement for the amateur who has the necessary means and facilities at his disposal.

A great many readers will content themselves with something a little less complete and consequently not quite so efficient. Quite a workable earth for a transmitting station can be made by burying two plates of the beforementioned size (3 feet by 2 feet) face to face and about six or eight feet apart, the lead from each plate being brought to the midway line between the plates and there jointed to the station earth lead. In any case we recommend the amateur to run out at least one wire under the aerial to supplement the plates. Whatever arrangement of plates is decided upon it is necessary to arrange the connections to the plates so that the common earth lead is symmetrical with regard to them. By this we mean that the wires connecting each plate to the station earth lead should all be of the same length. If this rule is not adhered to, the current will not be evenly distributed over all the plates. Also it is obviously necessary that the earth lead should be of at least the same cross section as the wires forming the aerial. It is not consistent to use, say, two 7/19 wires in the aerial and then employ a single strand of No. 20 for the earth lead. We shall return to this point later when giving specimen drawings of aerials and earths.

As soon as the prohibition of amateur working is removed The Wireless Press, Ltd., will be in a position to supply working drawings of all parts of apparatus described in these articles. It must again be emphasised that until the restrictions are removed no practical work must be attempted by the amateur. It may be that by the time this magazine has passed through the press some indication may be given of the Government's future policy in this matter.

* * *

SHARE MARKET REPORT.

Business in the various Marconi issues has been active during the past month. There has been considerable investment buying of both the Ordinary and Marconi Marine, both classes of shares showing a marked improvement in price since we last went to press.

Ordinary, £4. 15. 0; American, £1. 10. 0; Preference, £3. 17. 6; Canadian, 15s. 0d.; Spanish, 14s. 6d.; Marine, £3. 17. 6d.

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Library Table

"STATION X." By G. McLeod Winsor. London: Herbert Jenkins Limited, 6s. net.

THE novelist who takes as his subject a wireless station is on dangerous ground and must walk very warily. The novelist who writes on communication with the stars is treading an equally difficult path. But the novelist who combines both of these subjects in one volume is attempting a truly formidable task and one towards which detailed criticism is certain to be directed. It is only fair to say at once that in "Station X" Mr. G. McLeod Winsor emerges very successfully from the ordeal, and has produced a book in which the greater part is equal to Wells at his best and challenges comparison with Jules Verne. The story deals with a secret Admiralty Wireless Telephone Station erected on a remote island in the Pacific and containing a plant of such high power that communication can be effected directly with Whitehall. To this Station is sent a party consisting of a naval lieutenant, a wireless operator and a Chinese servant, these three forming the crew of the Station. Early in the book we learn that the operator and the lieutenant in charge are temperamentally entirely dissimilar; on the one hand the operator, a Scotchman brought up in a lonely glen away from the bustle and hurry of town life, is moody and dreamy, and none too well educated, while the lieutenant is arbitrary in his manner, dogmatic in his views, and with no point of contact socially with his subordinate.

In this state of affairs the young operator acquires the habit of taking long solitary walks around the island. One day, returning to the Station, he hears a cry and a revolver shot and finds both the lieutenant and Chinaman lying dead —the officer stabbed, with a revolver in his hand with which he shot his murderer. The shock of this terrible discovery almost unhinges the operator's mind, and after calling up Headquarters to advise them of the tragedy and request relief, he falls into a swoon. In this ecstatic state he speaks into the instrument, recording all he hears in shorthand, and on the arrival of the relieving party he is found rigid in his chair—to all appearances dead. It appears that the operator had been in communication with the planet Venus, the inhabitants of which disclosed a ghastly plot of the Martians to dominate the world and its inhabitants. Later a famous scientist, Professor Rudge, continues this communication and in the end after many exciting experiences the plot is defeated.

The author wisely avoids technicalities in his descriptions, but has thoroughly absorbed the "spirit" of wireless so that a technical reader is able to read the book with pleasure. The scenes upon the island and the descriptions of the communications with Venus and Mars are admirably done; the only fault we would find lies in the treatment given to those portions of the book which deal with adventures in England. Here the actors are badly depicted and the story tends to drag, but, in all, the volume is intensely interesting and will do much to stimulate thought in a direction which so far has been looked upon as purely the realm of romance.

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Personal Notes

THE LATE LIEUT. R. H. HIRST.

WE regret to learn of the death of Lieutenant Harold Hugh Hirst, only son of Mr. Hirst, chairman and managing director of the General Electric Co., Ltd. Lieutenant Hirst, who belonged to the 21st Manchester Regiment and was attached to R.E. Signal Service, died at his home in Portland Place of pneumonia following influenza, on the 24th of February. On the outbreak of war he was in France and on returning to England fell seriously ill. Immediately on his recovery he joined the Inns of Court O.T.C. and became Divisional Signal Adviser to the 30th Division in England, in February, 1916, he proceeded to East Africa, but owing to malaria and dysentery he was invalided home towards the end of the year. After a long and protracted illness he recovered and in June, 1917, was transferred to the Wireless Service, in which he acted as Instructor. He proceeded to France in the summer of 1918 and took active part in the June advance preceding the armistice. The strain of the campaign, however, broke down his health and he was invalided home at the end of October. He had not fully recovered when he fell a victim to influenza followed by pneumonia. He leaves a wife and one child.

A POSTHUMOUS HONOUR.

For services rendered to a Japanese destroyer which had been torpedoed in the Mediterranean Signalman Thomas William Woolcock, R.N., of Sefton Street, Southport, was awarded the Order of the Rising Sun (eighth class) by the Japanese Naval Authorities. We understand that the H.M. destroyer "Ribble" received the S.O.S. from the torpedoed vessel and at once went to assist. Woolcock was one of the party to board the torpedoed vessel and rendered every assistance in getting the survivors and the injured aboard the British destroyer. It is regrettable that this gallant sailor did not live to receive the recognition bestowed upon him, for on transferring to one of the British cruisers Signalman Woolcock contracted influenza, and pneumonia supervening he died on the 30th of October last. We offer our deep sympathy to his relatives, who must be intensely proud of the decoration conferred upon him.

AN AUSTRALIAN ECHO.

Mr. Jensen, who was relieved of his office of Australian Minister of Customs in consequence of the investigation by a Royal Commission concerning the Navy Department's purchase of wireless works at Randwick when he was Minister of the Navy, has gone to America. Reuter's Agency states that he sailed on January the 29th.

DEATH OF Mr. A. ALLAN.

We regret to learn of the death in Montreal of Mr. Andrew Allan, one of the founders of the Allan Steamship Line. Mr. Allan was President of the Canadian Marconi Company and Chairman of the Shipping Federation. He was deeply interested in wireless telegraphy from the earliest days and his influence and support at a time when Senatore Marconi's invention was looked upon as a scientific curiosity, was of the greatest assistance.

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Questions and Answers

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless telegraphy. Readers should comply with the following rules:* (1) *Questions should be numbered and written on one side of the paper only, and should not exceed four in number.* (2) *Queries should be clear and concise.* (3) *Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before.* (4) *The Editor cannot undertake to reply to queries by post.* (5) *All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom-de-plume."*

O.O. (Aldershot).—As the field covered by the general term "wireless telegraphy" is so wide and so rapidly expanding we cannot in these columns deal in detail with the opportunities of a career which the wireless service offers. However, it roughly divides into two branches, engineering and operating, and we think that in view of your experience as a telegraphist you should apply to one or other of the Marconi Companies for particulars of employment as an operator. We might add that positions as operators on commercial land wireless stations are generally filled either by men who are expert in land-line telegraphic work or by long service seagoing operators. Wireless engineers of the Marconi Company are required to have had a training in engineering at certain approved institutions.

I.M. (Sunderland).—We have not heard of any questions on the subject of Valve Receivers being asked in P.M.G. Examinations held up to the present time. When these Receivers are more widely used for commercial purposes the Post Office Examiners will no doubt ask the candidates to answer questions on the subject.

M.O'N. (County Cork).—Your enquiry should be addressed to:—The Traffic Manager, The Marconi International Marine Communication Co., Ltd., Marconi House, Strand, London, W.C.2.

F.G.G. (Gillingham, Kent).—The Marconi Free Training Scheme for operators has now ceased and we do not think there is any possibility of its re-establishment.

A.H.S. (B.E.F.).—The Engineers of Marconi's Wireless Telegraph Co., Ltd., are required to have studied at one of certain approved Institutions, a list of which can be obtained from the aforesaid Company. From what you say of your previous experience we are not sure that you would at present qualify either as a draughtsman or as a general wireless engineer. We advise you to apply direct to the Company.

S. G. L. (Bournemouth).—(1) Undoubtedly direction finding will be a permanent feature in future commercial wireless work. (2) It is possible that you would find employment as a wireless operator engaged on direction finding work provided that you were able to pass the Postmaster-General's examination, the medical examination, etc. (3) You should apply to:—The Traffic Manager, The Marconi International Marine Communication Co., Ltd., Marconi House, Strand, London, W.C.2.

W.D. (Beeston).—(1) We are unable for several reasons to state the cost of a ¼ k.w., ½ k.w., and 1 k.w. Marconi sets. These sets are not as a rule sold outright, but are generally supplied at a yearly rental. Then, a bare description of an installation as being of a certain power is insufficient because no mention is made of the size of the aerial required or whether emergency gear is to be included. (2) We think the Marconi Company will be in a position to supply amateurs with portable wireless sets in the near future.

A.E.W. (Catford).—The information you require was published in the WIRELESS WORLD for May, 1918. Apart from the question of physical fitness and general education, we may say that the age of an applicant for a position as engineer in Marconi's Wireless Telegraph Co., Ltd., should be from 21 to 25 years, and he should have had two or three years college training in general engineering subjects and a further two years' mechanical engineering training in the workshops. A diploma in electrical engineering is necessary as evidence of competence. The following London institutions provide a suitable course of training:—City and Guilds (Engineering) College, City and Guilds of London Institute, Faraday House, Finsbury Technical College, King's College, Northampton Polytechnic Institute and University College.

G.H. (Isle of Wight).—(1) For permission to experiment with wireless telegraphy apparatus you should apply to the Secretary, G.P.O., giving full details of what you wish to do. (2) You will no doubt be able to obtain the apparatus you need from Marconi's Wireless Telegraph Co., Ltd., Marconi House, Strand, W.C.2., although this depends largely upon whether you obtain official permission to purchase.

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J.A.V. (Ealing).—Asks if an Electrolytic detector in series with the aerial will work in practice. His telephones are connected in series with two dry batteries across the detector.

Answer.—In the first place an electrolytic detector is a high resistance detector, and therefore needs the application of a high voltage to render it efficient. A detector that can be used efficiently directly in the aerial circuit, must be of the low resistance type, such as a magnetic detector, as in the lower part of the aerial the current flowing is due to a low voltage.

It would therefore be much more efficient to connect the detector in series with the telephones and batteries across an inductance coil, possessing large inductance, in series with the aerial. If available a potentiometer of about 300 ohms should be connected across the battery and one of the telephone connections brought to the slider.

Question 2.—Asks if an A.T.I. and A.T.C. are required. As stated above an aerial inductance is almost an absolute necessity in any receiver. An aerial tuning condenser is not so, for the reason that a condenser in the aerial circuit has the effect of shortening the wavelength of the aerial circuit below the fundamental wavelength of the aerial. The lengths of aerials generally used by amateurs usually give a fundamental wavelength low enough to dispense with an A.T.C.

Question 3.—Asks if it is possible to pick up anything with one, or more aerial wires in parallel, hung across a room. To this question we can only say no. If J.A.V. had several magnifying valves and the necessary apparatus it would be possible, but certainly not with the apparatus he seems to have at his disposal.

Question 4.—The object of an A.T.I. is to allow the aerial to be tuned to the wavelengths of incoming waves by either decreasing or increasing the amount of inductance in the aerial. Since the aerial forms one plate of a condenser and the earth the other plate, cutting down the length of the aerial has the effect of reducing the capacity, and therefore, less energy can be transferred to the detector circuit. Hence it is not practicable to cut down the length of an aerial too much and make up for the loss of both capacity and inductance by the addition of extra A.T.I. In determining the length of an aerial to be used for receiving work it is usual to reckon that the fundamental wavelength of the aerial shall be about double that of the lowest wavelength it is desired to receive, and then of course adding inductance to tune to the longer waves.

It seems to us that J.A.V. has not yet mastered the underlying principles of Wireless Telegraphy, or the proper working and value of the various pieces of apparatus used, and we would strongly recommend him to study thoroughly an elementary text book on the subject.

J.R.C.H. (Leeds).—Asks: Whether two-slide primary and secondary tuning coils have yet been wound to pay commercially. He has read that they are deemed practically and commercially impossible.

Answer.—If J.R.C.H. is thinking of the primary and secondary tuning coils such as are used in receivers, we are quite at a loss to understand why it has been deemed practically and commercially impossible. The Marconi Company have used for many years a two-slide inductance on some of their small transmitting and receiving sets and probably the majority of amateurs use them in their aerial circuit.

There are various disadvantages in them, however, which render their use in some receivers detrimental. The slide usually makes contact with several wires at once, especially if the wire be of small gauge, thus causing these turns to be short circuited. Another point against their use is that the narrow strips of wire along which the slide makes contact become oxidized on exposure to the air, thus sometimes causing a bad contact with the slide.

If J.R.C.H. has in mind the secondary and primary of tuning inductance of any transmitting set above about 250 watts he will find that these inductances usually consist of a few turns of heavy wire, or in the case of very large sets of copper tube, in which case tappings are made to the turns by means of a flexible connection fitted to a plug and socket.

W.F.B. (Fleetwood).—Wants a set of instructions for the working of Field Station sets "similar to my own set." He also sends us an "approximate" diagram of connections of his set. In the first place we should like to ask what an "approximate" diagram of connections is. Surely a diagram of connections is either right or wrong, and there can be nothing approximate about it. We have looked through this diagram and have only one fault to find with it, and that not a serious one. He connects his telephones across his crystal, whereas the usual method is to connect the telephones in series with the crystal, as for the average crystal this method gives better results.

We are somewhat at a loss to know why W.F.B. wants a set of working instructions of Marconi Field sets, as they would be of very little use to him in helping to work his own station. We think it would be much better for him to obtain R. D. Bangay's Principles of Wireless Telegraphy, published by the Marconi Press, and learn the function of each piece of apparatus used in a transmitter and receiver. Having done this he would then be in a much better position to use his own set efficiently, and to solve any little difficulty he came across.

We should like to draw W.F.B's. attention to the point that we cannot undertake to return diagrams of connections, etc., and a copy of all diagrams should always be kept for future reference.

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THE
WIRELESS WORLD

No. 74
Vol. VII

MAY
1919

Twenty-six Days on a German Submarine.

By M. J. McGrath.

DOUBTLESS there have been many unpleasant sensations at sea during the last four years; to a merchant service sailor there are few, if any, more unpleasant than the crash of a torpedo and the sickening lurch of his stricken ship.

It was the sound of such an explosion that woke me violently on the morning of May 2nd, 1918.

It was an experience to which I had already become accustomed—the dull thud of the explosion, the lurch of the halted vessel, the smell of burnt powder, the slow rolling of a helpless ship, in the first agony of her struggle with the all claiming sea.

I rushed from my sleeping cabin towards the Wireless Room, over sloping decks where the grey smoke clouds wreathed like a fog, only to find my apparatus hopelessly beyond repair.

I reported to the bridge, sunk all papers relative to the private working of the ship and then, since nothing else could be done, prepared to take my place in the boats. My junior had already gone and with the pilot and the skipper I left the ship.

The vessel had heeled over to starboard and it was almost possible to walk down the port side to the boats, one of which, almost crowded with men, lay off at a distance of about ten feet from the side. We managed to get into this boat, the painter was cut and we pushed off. I was crouched down in the bows and had a chance of watching the men around me. One or two of the Engine Room hands were badly scalded, nearly all were soaked with water, and every face bore a tense, strained expression, the look of one who waits with misgiving for destiny to unfold itself.

Expressions swiftly changed, in some cases to looks of horror, in others of despair, indifference or anger, as the submarine coming to the surface about half a mile away, opened fire on the sinking ship.

After a few rounds had been fired the

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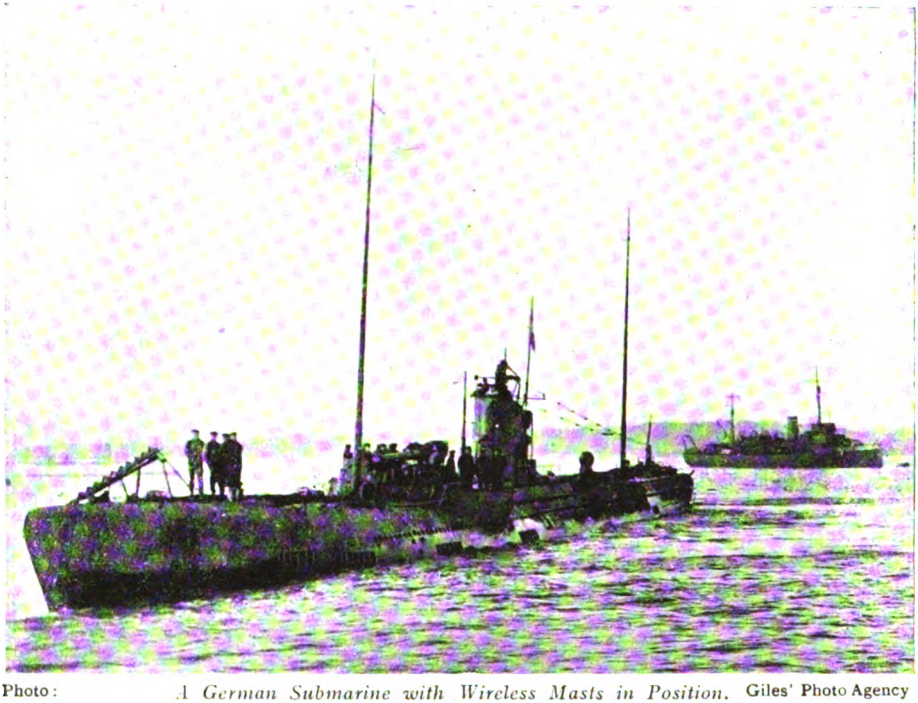

Photo: *A German Submarine with Wireless Masts in Position.* Giles' Photo Agency

magazine blew up and the vessel took fire. It was a picture never likely to be forgotten by those who watched; two small boats crowded with drenched, half-wakened, half-frightened men tossing on a dull grey sea; the long dark body of the submarine with her two guns flashing, and in the near background, framed in fire, the black hull of our ship, slowly sinking, looking like some animate thing which struggled for life in the grip of the sea.

In the silence that followed the hiss and crackle as the burning topmasts sunk beneath the water we turned and saw to our dismay that the U-Boat was heading in our direction, bearing down on us at a rapid rate.

She came through the waters with what seemed to us astonishing rapidity, the sea foaming and seething around her as she cut the water like a knife, the frame of her conning tower looking more like an armoured motor car than anything else in the world. I did not realise how well I was to become acquainted with that conning tower in the near future.

As she drew nearer we could distinguish the figures of the men upon her decks, the crews at their guns, and the officers on the tower-head, and I noticed with no great solace to my peace of mind about a dozen men covering us with rifles. They signed to us to lower our sail which we immediately did and with a swift turn the U-Boat laid us neatly alongside her.

Her crew were dressed in high boots and coats of what seemed to be rubber and at first sight it was difficult to distinguish between officers and men, the only difference, in fact, being in the caps, the men wearing the peculiar-shaped flat

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Photo: *A U-Boat Crew Surrendering to a British Officer.* Giles' Photo Agency

Inset: The Author of this Article, Mr. M. J. McGrath.

caps of the German sailor, and the officers the peaked cap and gold crest of the "Kaiserliche Marine."

An officer, naturally enough speaking in perfect English, called for the captain; slowly but without any change of expression the skipper, a man of some sixty years of age climbed aboard. The second call came for the "chief wireless man," and in a sort of daze, I also clambered on to her wave-washed decks. Eventually one of our gunners joined us, we were hustled below, the hatches banged down and we heard the swish of the water as we got under weigh.

I find it a matter of great difficulty correctly to describe my feelings at this particular period on first coming aboard the U86.

We were taken to a small cabin amidships, questioned, searched and marched away.

As I marched aft under the gentle guidance of a genial gentleman with a large magazine revolver, past rows of faces which to my distorted fancy seemed to be lit up with diabolical grins, my feelings were those of one who is going through a nightmare of a particularly vivid and frightful nature, and through it all ran a vague, quite impersonal wonder as to the manner in which I was to be killed. I was marched into the after chamber, where seated on a torpedo I was the subject of general and not unkindly attention from different members of the crew.

During twenty-six nights, when it was possible to sleep, I slept on a mattress of sorts on that torpedo. I took my food on it, sat on it, lay and dreamt on it, got up and sat down again on it, and then started the whole programme over again.

Experiences on board were many and

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varied. One might say that life on a submarine is crowded with innumerable happy little events which pass the hours which otherwise might become monotonous. It was hard to be down there a prisoner among the dirt and filth, sometimes not hearing a word of English for days. It was hard to be there with a beard getting longer and longer every day and the grime on your clothes and your body becoming thicker and thicker daily with never a wash or a shave. But you never got the chance to be miserable for long. An English or American destroyer would come along and drop depth charges on you for an hour or so, or a flock of aircraft, travelling at lightning speed would suddenly appear from nowhere and swoop down upon you and then a general scatter certainly took place.

No, I must admit that one of the inestimable advantages of submarine life is that one does not have much time to brood.

There was, however, an occasion which I shall always remember when during 50 hours we lay at the bottom, while above us the destroyers and chasers passed incessantly each one dropping its quota of good wishes and departing. Towards midnight of the second night, only one electric light was left burning in the whole ship; so low had the accumulators become that only this one light could be spared to see by. Most of the crew were clustered around this light, it was the least gloomy part of the vessel, waiting with varying expressions for either the enemy above to go away, or for Death to come down, on the swift wings of a bomb, down to the very sea bottom to claim his own.

Later the bombardment lifted and in slow jerks we raised ourselves through the sea, to the accompaniment of sixty throbbing hearts that doubted and hoped alternately, as the submarine stopped, then once again started with ever increasing effort in her climb up through the water to the surface above and to Life.

Still it is really useless attempting to describe the innumerable occasions on which we were either hunted or hunting. What is the good of speaking about one's feelings at the times when, at the sighting of any of our aircraft, we made that sickening swoop down through the very heart of the sea, when the air grew hot and heavy and the terrific pressure beat against the ear drums and the eyes seemed to be on the point of bursting from their sockets.

To talk of one's impressions, the rattle of the mine chains, of the whizz of the depth charges from your own destroyers, of the moan of the decoy ships' shells is certainly a difficult matter, but there is another side which is harder still to speak of. I refer to the times when in a silence-stricken ship, amongst men who stood immovable at their posts at the tubes, you crouched listening for the sudden spat-out word of command and during the eternal seconds that followed while the torpedo sped on its way and you waited for the splitting crash of the explosion, you muttered a sort of prayer that the torpedo might miss the ship that was sailing so bravely through the dark night, that the lives of the men who were sleeping unconscious of harm might be spared.

Yes, the life was hard, the conditions bad, the food vile, the danger and misery incessant, but worst of all was the realization of your captivity almost in sight of your own home.

God, it was terrible to see the sun rise day after day over the English coast, sometimes to watch it sink below the purple line where the Irish hills meet the sky, to watch the gulls swoop and circle over a sun-kissed sea and to think that you might never see the English

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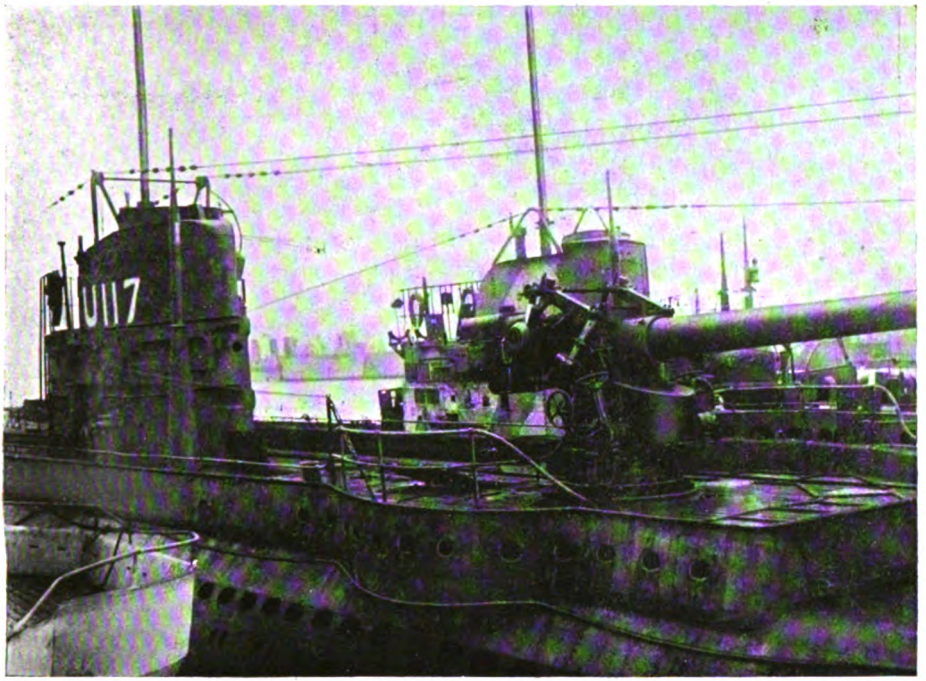

Photo: *U.117 with her formidable gun.* Giles' Photo Agency

coast, never again look on the Irish hills or watch the gulls at play, but that possibly all that waited for you was Death—Death in a thousand terrible forms and at the best, maybe, a quick end and an iron tomb on the slime of the ocean's bed.

So the days went on until at last the day came when we steamed up the Kiel Canal, that Canal where the ships of the English Navy were to follow in so few months, and finally laid up alongside the German depot ship in the harbour at Emden.

I do not propose to take the reader further with our German tour or to paint any pictures of that plague spot, Brandenburg Camp, but will leave him here, having carried out, I hope, in some little degree my original intention of trying to give some idea of the experience of a merchant service man taken prisoner by a U-boat.

Just a few more words in conclusion. It is apparently a general illusion that all German submarine men are murderers and barbarians. I consider it my duty to state that after my experience of them I cannot speak too highly of the German Navy men, with, of course, certain exceptions. The German military element I found exactly the reverse. Another point, with reference to the people at home who have not yet realised the work done by the Merchant Service during the war, let me offer one suggestion. When you compare the respective merits of the Navy and the Merchant Service, don't forget to give due consideration to all points and then when you have thought it all over, just tack this on to the end, namely, that the man who hunts has got a better job than the man who is hunted.

Believe me, I have found it out.

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GREENLEAF WHITTIER PICKARD

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Personalities in the Wireless World

THIS month we introduce our readers to Mr. Greenleaf Whittier Pickard, whose name is familiar to all who have followed the development of wireless receiving apparatus. Born in 1877 at Portland, Maine, Mr. Pickard received his early education at Westbrook Seminary and the Lawrence Scientific School, passing thence to Harvard and to the Massachusetts Institute of Technology. At the age of 22 he began " radio " work at Blue Hill Observatory, Milton, Mass., where under a grant from the Smithsonian Institution he engaged in an investigation of long aerials for wireless telegraphy. In 1901 he associated with Mr. Harry Shoemaker in one of the early American Radio Companies and in 1902 joined the engineering staff of the American Telephone and Telegraph Company. Mr. Pickard remained with that firm until 1906, having developed meanwhile a system of radio-telephony. Since 1906 he has been consulting engineer to the Wireless Speciality Apparatus Company.

Besides having practised as a patent expert Mr. Pickard is an inventor and has taken out some hundred patents in the United States and other countries. In the course of extensive researches on crystal detectors he discovered the rectifying properties of a silicon-copper contact, and the popular Perikon detector.

In 1909 he conducted some quantitative experiments on the subject of the effects of light and darkness on wireless transmission. Using a zincite-bornite contact as detector he measured during day and night the relative intensity of signals received from the Marconi station at Glace Bay. These values, obtained by the means of a telephone with a variable shunt, he plotted against time and the resultant curve showed that with the particular apparatus employed the ratio of the current in the telephone about midnight to that during daytime was approximately 30 : 1. The same curve strikingly confirms Mr. Marconi' statements concerning the unfavourable effect of dawn on wireless signalling, for the relative intensity of the signals dropped from 6 to 2 between 3.40 a.m. and 4 a.m., rising rapidly to 6 again at about 5.15 a.m.

Mr. Pickard is a Fellow of the American Institute of Electrical Engineers and a member of the American Chemical Society, the Society of Chemical Industry and the Institute of Radio Engineers, being elected the President of the last for the year 1913. Perhaps the most interesting fact about this gentleman, from the point of view of the literary world, is that he is a grand-nephew of the poet Whittier. Is there any connection, we wonder, between this and the fact that he has made his home in Massachusetts, the acknowledged nursery of literary culture in the United States?

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Wireless Maps.

By J. St. Vincent Pletts.

THE achievements of wireless telegraphy during the war have been many and great, and amongst them must be reckoned the part it played in bringing the Zeppelins to a fiery end, and destroying the high hopes built upon them by the Germans. The first step in combating this menace was the accurate location of approaching Zeppelins, and, as they were bound to make large use of wireless telegraphy for their own navigation, it was obvious that direction-finding stations on a wide base could supply the necessary information. No sooner, however, were the requisite stations erected than a subsidiary problem presented itself, namely, how to set out on the map the various directions found, so as to give an accurate intersection, without loss of time in calculating the great-circle course taken by the wireless waves.

I had the good fortune of discussing this matter with my able friend, Captain P. J. Edmunds, and we agreed that it was essential that the map should be orthodromic, that is to say that all great-circle courses should be straight lines, and desirable that it should be azimuthal, that is to say that all directions from a point as near as possible to all the stations should be true. We saw that these conditions would be fulfilled by a projection from the centre of the earth upon a plane tangential at the selected point, and he therefore had this projection drawn by the Royal Geographical Society, and thus the first wireless map was born. In this map a protractor, which differed only slightly from true angles, was drawn around each direction-finding station, so that it was only necessary to draw straight lines for the directions found by each station to get an intersection giving the true position of the sending station. As the map contains much other information which is still secret I cannot reproduce it here, but I hope that, when the time comes, Captain Edmunds will publish it, together with the mechanical adjuncts he used for minimising the labour of plotting the readings.

Some months later the Admiralty, in spite of their earlier scepticism, printed this map and called it a Gnomonic Chart of the North Sea. About a year later a friend of mine, who had been engaged on similar work in France, was home on leave and called to tell me that he had met a Professor of Cartography who had informed him that we ought to be using the zenithal instead of the gnomonic projection. I again discussed the matter with Captain Edmunds, and, though neither of us knew what either zenithal or gnomonic meant, we both did know that the projection in use was the right one for the purpose.

For my part I could not let the matter rest there, and determined to find out what a point vertically overhead, as well as what the style of a sun-dial, could possibly have to do with a map projection. The result of this determination was to plunge me immediately into the most awful morass of confused and inaccurate terminology which I have ever found in connection with any scientific subject. I found, for example, that zenithal was used as a synonym of azi-

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muthal, not because it meant anything, but because, forsooth, the latter word is a little difficult to pronounce at first; and that gnomonic was used for orthodromic because there is a B in both—at any rate I have not been able to discover a better reason. Thus our azimuthal orthodromic map was actually, in the Professor's own language, a zenithal gnomonic projection. This confusion was no doubt partly due to the fact that up to this time, as far as I have been able to ascertain, this projection had only been drawn with the plane tangential either at the equator or at one of the poles, which, of course, would not be azimuthal for the North Sea. Quite recently, however, Dr. Eccles has published* an orthodromic map which is azimuthal with respect to Greenwich, and it is indeed largely at his suggestion that I am now publishing this brief account of some of the work I have done on the subject.

The first thing to notice about what are generally called "map projections" is that they are not maps and are very seldom projections, and that the excellent name "graticule" has therefore been given to the mesh of lines of latitude and longitude upon which a map is drawn. Now it seems to me that the construction of graticules has hitherto been approached from three different points of view. First, they have been regarded as purely geometrical projections of the sphere upon a plane. Second, they have been approached from the point of view of the draughtsman, whose principal concern is to get a graticule which he can draw with ruler and compass. Third, they have been constructed for the benefit of the user, and therefore exhibit some special property These considerations, or combinations of them, seem to have given rise to all, or nearly all, the existing graticules, and though I have, by adopting a new or wider point of view, succeeded in producing a number of new graticules, I only propose now to deal with those which exhibit some special property of value to the user, as he seems to me to have been somewhat neglected. Perhaps some day I shall find time to treat the whole subject more fully.

The useful properties of graticules may be divided into two broad classes according to whether they are properties of the whole area or only properties with respect to a point. The properties of the whole area are loxodromism, orthodromism, orthomorphism and orthoagrism. Loxodromism, or the property which makes all true compass courses straight lines, is only possessed by Mercator's Chart, or a projection or skew thereof, so that the graticule is completely determined. Orthodromism, or the property which makes all great circles straight lines, is only possessed by a projection from the centre of the sphere, or a projection or skew thereof, and requires, as we have seen, the selection of the tangent point to completely determine the graticule. Orthomorphism, or the property which gives correct local shapes and implies an orthogonal graticule, may be possessed by many different types of graticule, and is by itself indeterminate. The projection of the sphere from the point at the opposite end of the diameter which passes through the tangent point, generally called the stereographic projection, and Mercator's Chart, which is not a projection, are both orthomorphic graticules. Orthoagrism, or the property which gives correct areas, is also quite indeterminate by itself, and, unlike orthomorphism, it is unspoilt by orthogonal projection or skewing. Orthoagric graticules are usually called equal-area, but I prefer to give them a name analo-

* Maps for Radiotelegraphy and Aeronautics, by W. H. Eccles, published in The Year Book of Wireless Telegraphy and Telephony, 1919.

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gous to those of the other properties of the whole area.

Mercator's Chart is well known and largely used by mariners, but I do not think anything like full use is made of orthodromic charts. The calculation of great circle courses is not a very simple matter, whereas it is easy, whenever a position is determined, to draw a straight line between it and the destination on the orthodromic chart, and to plot this line back on to Mercator's Chart, from which the varying compass bearings can be directly taken. Orthomorphism and orthoagrism are of no interest from the point of view of wireless, so I will pass on at once to those properties which are of special interest.

The properties with respect to a point are (*a*) true distances to or from a point, which is generally called equidistant, but which, in spite of the present use of the word, I am going to call zenithal, (*b*) true directions from a point, which is called azimuthal, and (*c*) true directions to a point, which is called retro-azimuthal. None of these completely determine the graticule, and all can therefore be combined with other indeterminate properties, while all projections are of course already azimuthal for the tangent point. From which it follows that the azimuthal orthomorphic graticule is identical with the stereographic projection already mentioned, so that the same map is reached through two entirely different channels. With regard to my use of the word zenithal, it has the advantages of being of similar origin to the word azimuthal, and of already having an analogous meaning in astronomy, where the zenithal distance of a star is the complement of its altitude, so that it seems to be the natural word for the purpose, while no apology is necessary for abandoning the misuse of the word equidistant. As far as I am aware the only retroazimuthal map hitherto drawn has straight parallel meridians, and was drawn by the Egyptian Government Survey to show the faithful, wherever they might be, the direction of Mecca. But it is the graticules determined by the inter-combinations of these three properties with respect to a point which produce what may be properly called wireless maps.

A symbolical classification of these three properties with respect to a point and all their inter-combinations is given in Fig. 1, where the double circle indicates that the graticule is completely determined by the selection of the points. Thus we arrive at six types of wireless maps, viz.:—

1. The zenithal-azimuthal graticule, which gives true distances and directions from a selected point, and which is, I believe, the only one of the six which has hitherto been drawn, or even contemplated. Such a map would be useful for a fixed station doing long distance reception from all directions. It would of course be possible to draw a graticule which gave true distances from one point and true directions from another point, but there does not appear to be any use for it.

2. The zenithal-retroazimuthal graticule, which gives true distances and directions to a selected point, and which would be of great use if it were possible to determine distances as accurately as directions by wireless telegraphy, for it would enable a ship or an aeroplane to plot its position direct from the readings obtained from a single station. In Fig. 2 I have drawn such a graticule for the whole world with respect to Clifden. In order to prevent overlapping and to get it all in the right way round, I have reversed the portions outside the poles (which are represented by semi-circles), and therefore the directions, which are given clockwise in degrees from the north, have to be taken from the upper reversed half of the peripheral protractor for these portions of the map, and it is

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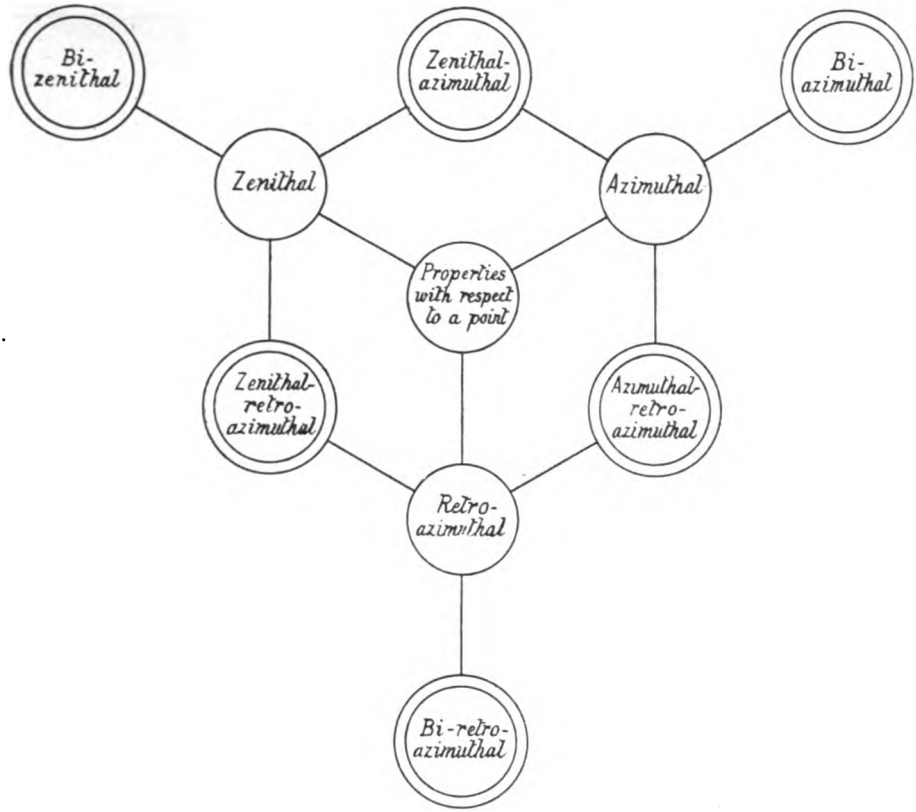

Fig. 1.

best to turn the map upside down when referring to them. It is an interesting fact, brought out very clearly by this map, that Clifden is not between 2,500 and 9,900 miles (*i.e.*, the distances of the poles) east or west, nor of course south, of any place in the world. A practical zenithal-retroazimuthal chart for the purpose of navigation in the Atlantic would of course consist of only the central portion of this map on a much larger scale. Again it would be possible, but of no use, to draw a graticule which gave true distances to one point and true directions to another point.

3. The bi-zenithal graticule, which gives true distances from two selected points, and which would be of great value if distances could be determined more accurately, as it would enable the position of a moving station to be determined by readings obtained either at or from two fixed stations.

4. The azimuthal-retroazimuthal graticule, which gives true directions from one and to another selected point, and which does not appear to be of any special value.

5. The bi-azimuthal graticule, which gives true directions from two selected points, and which would be of great value for the purpose of determining the position of moving stations from two fixed direction-finding stations, for the intersection of straight lines drawn at their true angles gives the position.

6. The bi-retroazimuthal graticule, which gives true directions to two selected points, and which is, in the

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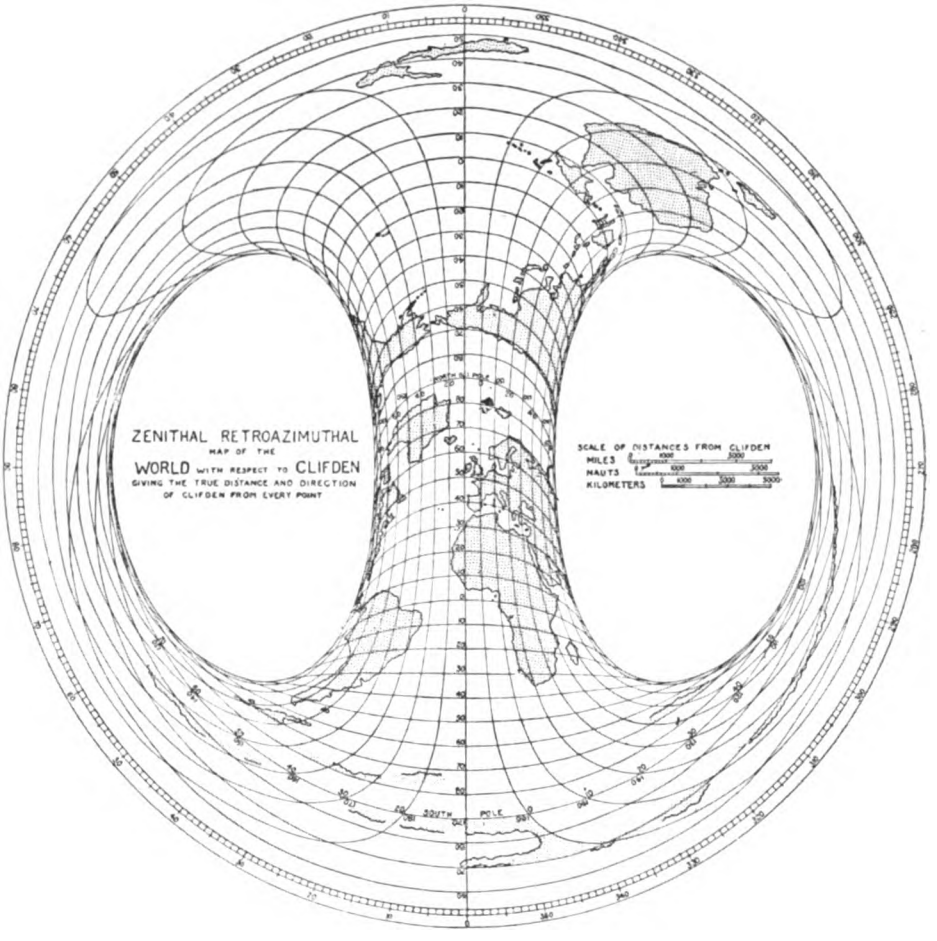

Fig. 2.

present state of development of wireless telegraphy, the most valuable for the purpose of navigation. In Fig. 3 I have drawn such a map for a part of the Atlantic with respect to Clifden and Glace Bay. A ship with direction-finding apparatus has only to draw straight lines at their true angles through these two stations, which are provided with protractors for the purpose, to determine its position by their intersection. Then, as already explained, the position can be put on to an orthodromic chart and joined by a straight line to the destination, and this straight line can be plotted on Mercator's Chart to give the course, without any calculation at all, and with very little loss of time. The area in the vicinity of the great circle joining the selected points cannot be shown on this graticule, but it would be of little use if it could be shown, for accurate intersections cannot be obtained with such obtuse angles.

This exhausts the six inter-combinations of the three properties with respect to a point, but arising out of the zenithal property are any number of indirect zenithal properties which can take its place in any of these combinations. For

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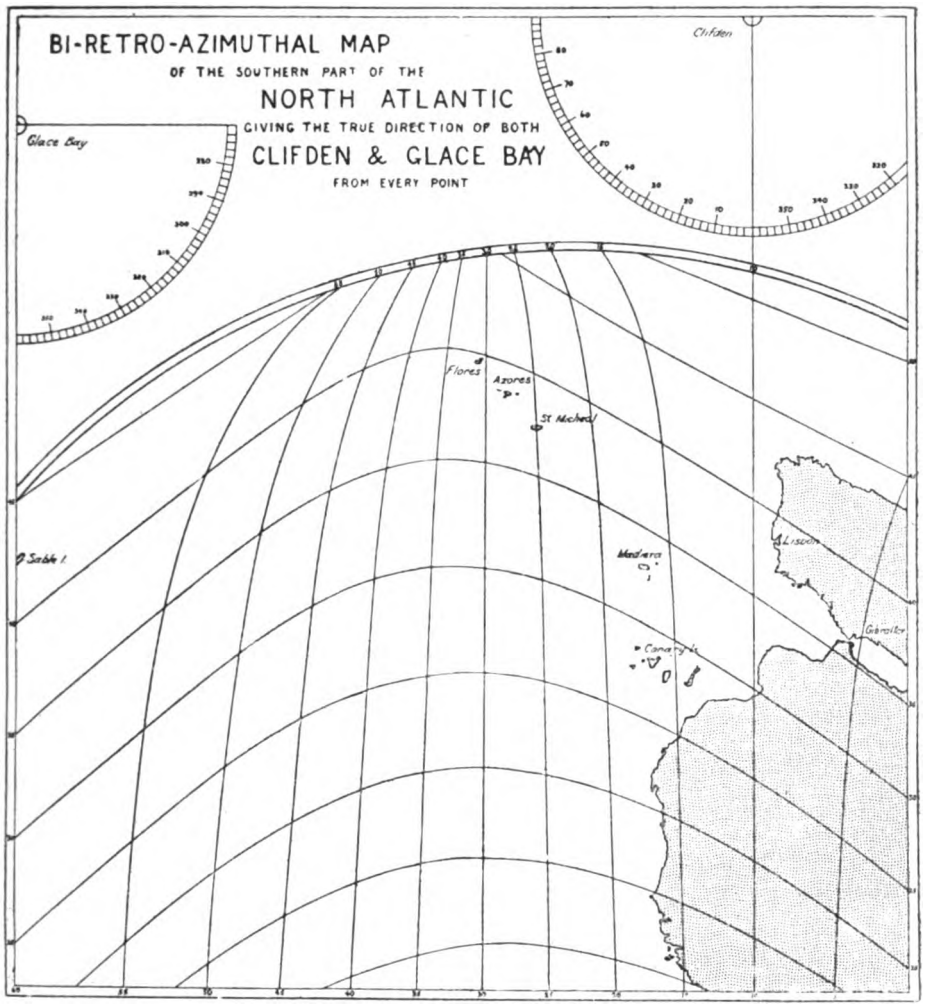

Fig. 3.

example, the distances measured on the map from the selected point, instead of being proportional to the true distances measured on the sphere, may be proportional to the readings of any instrument by which the distances can be determined, or to the power required at the transmitting station to produce waves of a certain amplitude at those distances, or to any property which varies with the distance, such as the height of the intervening mountain due to the curvature of the earth.

Similarly the azimuthal properties may be replaced by any property which varies with the direction, the most obvious being the magnetic instead of the true directions, though such graticules could only be of use for a short time. It would even be possible to represent distances by angles and directions by lengths, and, though this would make it possible to represent directions to and from the same point on one map, it is doubtful if such graticules would ever be of any use.

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Digest of Wireless Literature

A BRIEF TECHNICAL DESCRIPTION OF THE NEW SAN DIEGO, PEARL HARBOR, and CAVITE HIGH POWER NAVAL RADIO STATIONS

By Leonard F. Fuller (Chief Electrical Engineer, Federal Telegraph Company). Proceeding of the Institute of Radio Engineers.

As mentioned in Capt. Bullard's article, 11,000-volt, 3-phase, 60-cycle power will be delivered to the new San Diego high power radio station. The power equipment is being manufactured by the General Electric Company and will consist of the usual oil switches, switchboards, and motor-generators used in power work.

The motor-generators, which are in duplicate, will be 2-unit 4-bearing sets, consisting of 300 horse-power, 1,200 revolutions per minute, 2,200-volt, 3-phase, 60-cycle, squirrel cage induction motors, direct connected to 200-kilowatt, 1,200 revolutions per minute, 950-volt, compound wound, direct current generator with 2-kilowatt, 125-volt, over-hung exciters.

The temperature rises of the motors will be 40°C. for continuous full load operation and not over 55°C. for a continuous series of duty cycles of 1.5 hours on and 1 hour off at 125 per cent. of load.

The generator temperature rises will be 40°C. for continuous full load operation and not over 55°C. for a continuous series of duty cycles of 1.5 hours on and 1 hour off at 250 kilowatt output. The sets as a whole can withstand a 100 per cent. overload for short periods.

Duplicate 14-kilowatt, 125-volt, direct current, motor-generators with a complete set of spare parts will be installed also, for furnishing power for plant auxiliaries.

The Federal-Poulsen arc converter will be of the oil-immersed water-cooled type capable of furnishing 150 amperes radiation continuously, and 170 amperes for periods of 1.5 hours on and 1.5 hours off. The temperature rises will be 40°C. and 50°C. respectively for all current-carrying or electrical parts.

At Pearl Harbor, power will be supplied, as Captain Bullard states, at 2,200 volts, 3-phase, 60 cycles. This plant is similar to that at San Diego but of higher power. The large motor generators are provided in duplicate with a complete set of spare parts including spare armatures. They are 2-unit, 4-bearing sets, manufactured by the General Electric Company, consisting of 750 horse-power, 900 revolutions per minute, 2,200-volt, 3-phase, 60-cycle, wound rotor, induction motors, direct connected to 500 kilowatt, 900 revolutions per minute, 1,430-volt, compound wound, direct current generators with 3-kilowatt, 125-volt compound wound, over-hung exciters.

The temperature rises of both motors and generators will be 50°C. on a continuous series of duty cycles of 2 hours on and 1 hour off. High voltage direct current switchboards and control apparatus of a type used in electric railway work will be provided.

The Federal-Poulsen arc converter will be of the oil-immersed, water-cooled type, capable of furnishing 200 amperes radiation continuously and 250 amperes for periods of 1.5 hours on and 1.5 hours off with temperature rises

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of 40°C. and 50°C. as specified for San Diego.

On account of the oil immersion and water cooling of all coils and arc converter windings, this type of apparatus is extremely rugged and reliable. The arc transforms or converts the 1,500-volt direct current power into radio frequency energy without the use of rotating parts or radio frequency magnetic circuits.

The antenna loading coil will be of litzendraht cable supported entirely by porcelain. This cable will be 1.75 in. (4.45 cm.) in diameter, and the loading coil diameter will be 14 feet (4.26 m.).

The wave changer will be of the rotary type capable of throwing the plant on to any one of five wavelengths when operating at full power. This feature holds for San Diego and Cavite as well as Pearl Harbor and in all three the usual antenna grounding switches, transfer switches, etc., will be provided.

The generating equipment at Cavite will be identical with that at Pearl Harbor except that the power supply will be 220-volt direct current and no over-hung exciter will be used. The 500-kilowatt, 1,500-volt generator excitation will be supplied from the 220-volt direct current buses. At both Pearl Harbor and Cavite, special insulation and fittings for tropical conditions will be provided.

The arcs at Pearl Harbor and Cavite radio set at Cavite will be in every way identical with that at Pearl Harbor.

The arcs at Pearl Harbor and Cavite will be approximately 9 ft. 2.5 in. (2.81 m.) by 7 ft. 4 in. (2.23 m.) wide by 12 ft. (3.66 m.) long and will each weigh approximately 60 tons (54,000 kg.) under operating conditions. The San Diego arc is somewhat smaller and will weigh 21 tons (19,000 kg.) under operating conditions. The larger arcs will present an outside appearance very similar to certain types of vertical shaft hydro-electric generators.

"UBER ROHRENSENDER." *By A. Meiszner. Elektrotechnische Zeitschrift.* 13.2.19, *p.* 65.

IN the introductory part, the author expresses the opinion that the development of the transmitting valve has definitely settled the question of damped versus undamped oscillations, in favour of the latter. This is justified by the simplicity of the apparatus, the absolute constancy of wavelength and the wide range of waves which can be obtained. Indeed, it is a well-known fact that a valve can be made to generate oscillations of frequencies ranging from a few hundred millions (wavelength about one metre) down to a few thousands or even hundreds.

In view of these qualities, the valve, besides its use for wireless transmission, forms also an ideal source for measuring purposes.

The author next sketches the history of development of the generating valve, in so far as the Telefunken Company is concerned. The first attempts of this Company to use the valve as a generator date back to March, 1913. Originally a Lieben tube (with a low vacuum and specially prepared cathode) was employed. At 400 volts in the anode circuit an energy of 10-12 watts could be generated. With this tube, telephonic communication was established between Berlin and Nauen on 21.6.1913. A view of the apparatus is shown on Fig. 1. In practice, however, the type of the low-vacuum tube had very soon to be abandoned in so far as transmission was concerned, owing to its very short life, even at the low amount of energy mentioned above.

On the other hand, for heterodyne reception (the idea of which was ex-

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pressed by Fessenden a very long time ago), the apparatus proved to be quite satisfactory, as the energy required for this purpose is very small.

These first experiments with the Lieben tube showed that in order to

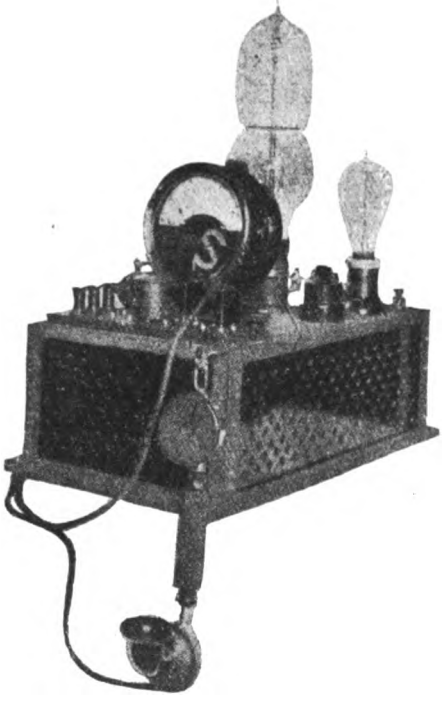

Fig. 1.

obtain a transmitting valve with a considerable output, high vacuum had to be employed. As the Telefunken Company depended on other firms for the evacuation of their tubes, the experimental stage took a comparatively long time. Only after the installation of their own evacuation-plant had been finished (May, 1914), quicker progress could be made, and in the beginning of 1915 the first practical valve transmitter (10 watts, 800 volts) was completed.

At this time, Langmuir's patents for the Kenotron and Pliotron reached Germany and were put at the disposal of the Telefunken Company. Langmuir's methods were adopted, and after overcoming certain constructional difficulties in connection with the grid and filament, a tube was constructed which could generate about 1 k.w. Fig. 2

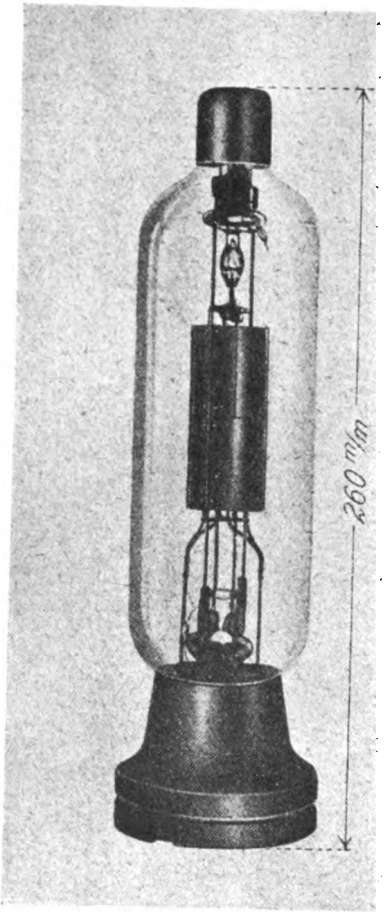

Fig. 2.

shows a generator for 200 watts. The anode is made of tantalum, and the V-shaped filament is attached at the top.

The advent of the improved construction has made it possible to employ several valves in parallel as well as to simplify the connection in the transmitting circuits.

A further difficulty has been met with

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in the design of an adequate H.T. source for the anode circuit, as H.T.D.C. machines were found unsatisfactory. After several tests, an A.C. source with a special type of rectifier designed by the Akkumulatoren-Fabrik A.G. was adopted.

The author states that with this arrangement the A.C. from a 500-cycle machine can be converted into a D.C. with a loss of 4 per cent. only. This type of rectifier is employed only for small amounts of energy, while for larger amounts the mercury rectifiers of the A.E.G. have been found more suitable. The very small energy (10 watts) which could be obtained from the transmitter built in 1915 was the reason why valves were introduced into the German military stations, only very late, in the Spring of 1917, and even then only for heterodyne reception. The use of valve transmitters and of receiving arrangements involving the reaction principle was commenced still later—a short time before the Armistice.

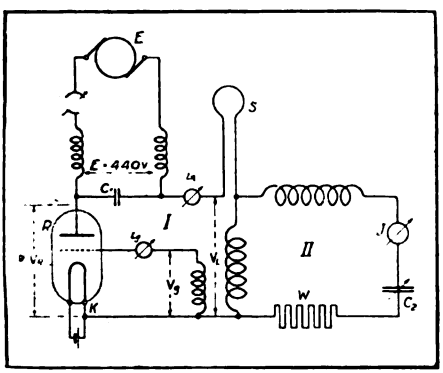

Fig. 3.

The author next proceeds to give an account of the phenomena which take place in the circuits of a generating valve. Without entering into a discussion of the numerous arrangements of the circuits (such a discussion will be given by the author's colleague—Dr. Vos) the author limits himself to the study of the characteristic circuits shown in Fig. 3.

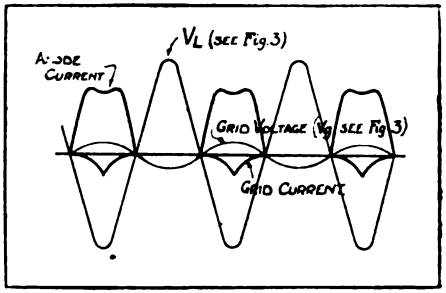

Fig. 4.

Experiments show that whatever the arrangement, there is always a *certain* coupling between the grid and plate circuits which gives the best results, and that the phase relations between the various currents and voltage is such as shown in Fig. 4.

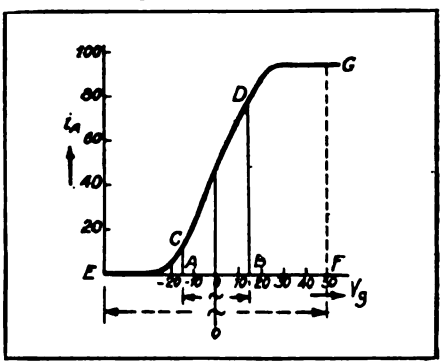

Fig. 5.

From the static characteristic of a valve (see Fig. 5) it is clear that if the grid voltage varies between sufficiently small limits, the law of variation will be exactly reproduced in the anode circuit, so that, for instance, if the voltage impressed on the grid follows a sine law,

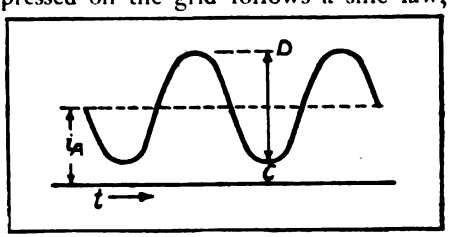

Fig. 6.

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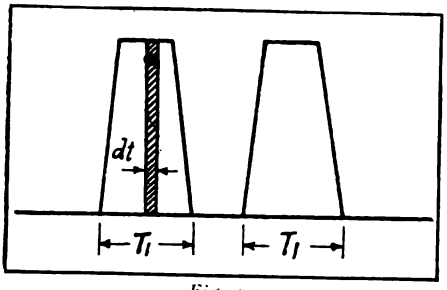

Fig. 7.

the current in the anode circuit will be given by the graph of Fig. 6, where the curve is a sine function of the time. If, however, the grid voltage varies between wide limits, the graph of the anode current will be represented by Fig. 7. This latter case is the one which occurs in a generating valve and has, therefore, to be specially investigated.

It is evident, that during the interval T_1 (Fig. 7) when current flows through the valve, we must have:

$$E = V_R + V_L \qquad (1)$$

(for the notation see Fig. 3).

Now, since L belongs to circuit II in which a sinusoidal current is flowing, V_L must also be sinusoidal. Therefore by measuring directly the effective value of V_L, we can calculate its value at any moment and determine by means

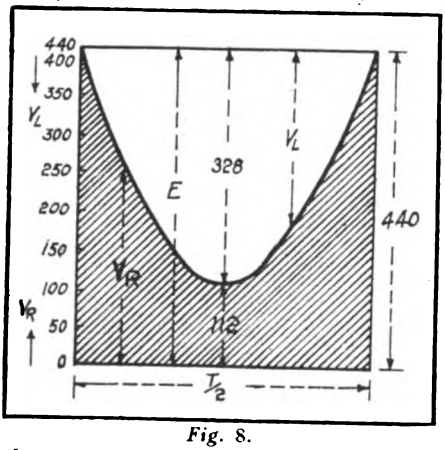

Fig. 8.

of equation (1) the momentary values of V_R. This is done graphically on Fig. 8 for a case when $E = 440$ vol. and V_L $eff = 232$ v.

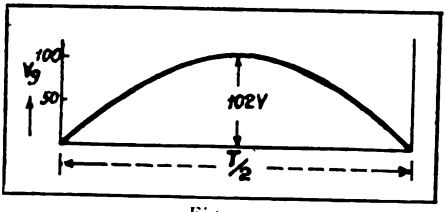

Fig. 9.

Again, since V_g is induced by circuit II, it must also be sinusoidal, and its value at any moment can be determined from its effective value, which can be found by direct measurement. For the case under consideration V_g $eff = 72.5$ v., and the graph is shown on Fig. 9. Let us now draw the static characteristics of our valve at different anode voltages as shown on Fig. 10.

By taking at any moment the value of the grid voltage (from Fig. 9) as the abscissa on Fig. 10, we can find the value of the anode current at that moment. For this purpose we have only to construct the ordinate corresponding to our abscissa, remembering at the same time that out of the several curves given on the figure that has to be chosen which corresponds to the value of V_R (as determined from Fig. 8) at the considered moment. By this method we can easily find, for instance, that at the moment when the grid voltage is 102 volts, the anode current will be 121 milliamps.

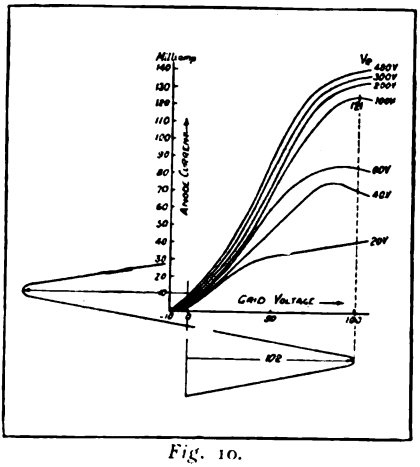

Fig. 10.

(To be concluded.)

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The Telegraph Communications Board.

THE FORMATION OF AN IMPORTANT NEW COMMITTEE

WE understand that the question of long distance telegraph communication is now engaging the serious attention of the War Cabinet and as a consequence a "Telegraph Communications Board" has been appointed with Lord Milner as Chairman. The appointment of this Committee will be widely welcomed, particularly in view of the recent traffic delays which have shown how urgent is the question of revision of the existing arrangements for communication between the Mother Country, the Colonies, and foreign countries. The first official intimation of the appointment of this Board was given by the Postmaster-General in a parliamentary answer to Sir Henry Norman, who enquired whether the Government was aware of the steps taken by the French and American Governments in the erection of state-owned high-power wireless telegraph stations in France and America.

Viscount Milner.
Photo: G. Vandyk.

Hitherto while no fewer than five home departments have been directly concerned in the matter of wireless telegraphy the Post Office has been the only department to act for the State. The result has been a long drawn out correspondence with the other offices very commonly culminating in nothing being done. Under the new plan each of the Government departments concerned will be represented on the Board, and thus matters will be thrashed out in a far quicker and more satisfactory manner than hitherto. Although there is not the slightest doubt that the new Board will do much to improve the arrangements for long-distance telegraphy, its attitude towards wireless will need to be carefully watched by the public, or there may be the danger of an attempt similar to that which signally failed in the United States to place wireless telegraphy entirely in the hands of the Government, with the consequent prohibition of amateur working and the suppression of the private investigator.

We have so far no advice of the constitution of the Board beyond that Lord Milner is to be Chairman, and Sir Henry Norman Vice-Chairman, but we presume that most, if not all, of the members of the "Wireless Board" to which we made reference in our April issue will be members of the larger committee.

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Stray Waves.

WIRELESS TELEPHONY AND AIRCRAFT.

DURING the past month or two the press—notably the daily press—has paid a great deal of attention to the subject of wireless telephony as applied to aircraft, the general tendency being to credit the Royal Air Force with having invented and perfected this means of communication during the war. Now, firstly, wireless telephony is not an invention but a natural development of wireless telegraphy. Its accomplishment did not involve the discovery of new fundamental principles or the invention of any new apparatus. Speech had been transmitted over great distances by wireless long before the outbreak of war and the various ways in which perfectly well-known pieces of apparatus were *connected* in order to obtain this result are the work of a number of experimenters who were quite unconnected with the R.F.C. or R.A.F. Secondly, circuits for wireless telephone sets both for reception and transmission were designed by the Marconi Company in the earlier days of the war and were entirely due to the efforts of that Company's experts. Naturally, improvements and refinements have been made possible by four years' experience of aircraft sets under fighting conditions, such as an increased degree of portability and better methods of fitting, but these are not the invention of or the perfecting of wireless telephony. The small weight and bulk of the aeroplane sets and the ability of the operator to hear messages in spite of the deafening noise of the engines are chiefly due to a modification of the Fleming valve and its circuits as worked out by a Marconi engineer. Given the wireless transmission of speech as *un fait accompli* the installation of the apparatus on ship, train, aeroplane or tank becomes a problem involving nothing more than mere adaptation to special conditions and requirements.

EARLY WIRELESS TELEGRAPHY.

In our March issue we re-printed from *The Electrical Review* a letter from Mr. Marconi in which he denied that when he first came to this country he received from the Post Office "the use of a considerable sum of public money" in connection with his early experiments in wireless telegraphy, as stated by Mr. A. A. Campbell Swinton. We now reproduce Mr. Swinton's reply published in *The Electrical Review* for March 7th—

"My object in writing to you on this subject on January 25th was to defend the late Sir William Preece against what seemed to me the very unfair suggestion that had been made in your columns that Mr. Marconi, when he first arrived in this country, failed to meet with sympathy in official circles, and I am glad to see that Mr. Marconi entirely agrees with my correction in this respect.

"I notice, however, that Mr. Marconi goes on to find fault with my statement that the assistance which he received from the Post Office 'included the use of a considerable sum of public money.'

"With regard to this, of course, I

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have never suggested at any time that actual payments were made by the Post Office to Mr. Marconi, but in order to remove entirely this idea which, though never put forward by me, appears to have existed, I may state that I have a recent letter from Sir John Gavey in which he writes: 'To my knowledge no monetary transactions of any kind took place nor were any payments made by the Post Office to Mr. Marconi during the period we were working in association.'

"This, however, does not in any wise affect what I did state in my letter to you which was that the Post Office gave to Mr. Marconi 'much technical assistance including the use of a considerable sum of public money which was expended in developing wireless telegraphy by numerous experiments carried out with the help of Post Office officials, including Mr. (now Sir John) Gavey.' Of course opinions may differ as to what sum of money may be described as considerable, but that substantial sums of public money were expended and considerable technical assistance given by the Post Office to Mr. Marconi in the manner I have stated is borne out by a printed official report by Sir John Gavey written in 1903, which I have before me, in which an account is given of the experiments 'instituted by the British Post Office' for the purpose of investigating Mr. Marconi's method, beginning in May, 1897, and in which it is specifically stated that 'the apparatus used at this time was partly Marconi's own gear and partly modified and re-designed appliances made in the Post Office workshops or purchased by the Department.' The report proceeds to give detail of 'the masts of rather over 100 feet total height,' and of induction coils and other apparatus and materials which the Post Office provided, and in some cases specially purchased for the purpose. Further Sir John Gavey in his recent letter to me, writing of 'such Post Office funds as were expended on Mr. Marconi's wireless experiments,' states that these were utilised 'to meet the cost of materials, labour, and travelling expenses of Post Office engineers in carrying out distant experiments, notably those across the Bristol Channel, where three temporary wireless stations were erected, manned, and subsequently removed by the Post Office staff.'

A. A. CAMPBELL SWINTON."

London, S.W. *March 3rd.* 1919.

A WIRELESS INSTALLATION DE LUXE.

Interesting details of the way in which President Wilson kept in touch with Washington and Paris during his recent voyages are given in *The Electrical Review* (Chicago). His messages were first sent by wireless from the *George Washington*, on which he travelled, to the U.S.S. *Pennsylvania*, which then communicated direct to America over any distance up to 2,500 miles, or with the French station at Lyons.

The *Pennsylvania's* apparatus includes a 30 kw. arc set for transmission with waves of 3,600 metres, a 10 kw. spark set for working coastal low-power stations, a short range valve transmitting set, and a short range wireless telephone apparatus, the latter two being used for communication with the *George Washington*. There are six receiving cabins, in which messages were intercepted from Annapolis (16,900 metres), New Brunswick (13,000 metres), Lyons (15,500 metres), Tuckerton (4,000 metres) and from various smaller stations on wavelengths of 600 metres and 1,000 metres. Of the four transmitters carried, only one employs the spark method, the long-distance work being done by an arc.

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INCENDIARISM BY ELECTRO-MAGNETIC WAVES.

A recent issue of *L'Industrie Electrique* contains an interesting account of a communication made to a recent meeting of the Academy of Sciences regarding the possibility of fires being caused by the action of aether-waves. As a result of the war wireless stations have increased in both number and power and M. Georges A. Le Roy undertook some practical investigations with a view to finding out whether certain conflagrations which could not be traced to the more ordinary causes might be attributed to wireless waves.

This is by no means a new question but one which crops up periodically, and we are able to state that it was investigated by Marconi's Wireless Telegraph Company as far back as fifteen years ago. Whilst this Company was erecting the wireless station at the Fastnet it was thought prudent to try beforehand whether the radiated electro-magnetic energy would actuate the fog-signal cartridge which was close by, and deliberate attempts to set fire to the gun-cotton by the agency of wireless proved unavailing even when pursued under conditions much more favourable than would obtain in practice.

On another occasion the Marconi Company carried out similar experiments in connection with the installation of wireless apparatus on board oil-tank ships, their results indicating no danger from induced sparking in respect to inflammable vapour in the open air. However, as a measure of precaution on these ships they screen with wire gauze all parts of their gear where sparking is likely to occur.

It would appear that up to the present the guilt of the aether-waves is not proven inasmuch as the induced sparks are cold and lack the energy required to produce combustion. The experiments described to the Academy of Sciences tended to show that if a concourse of unfortunate circumstances conspired to reproduce Hertz's detector spark-gap—such as a break in an iron hoop binding a bale of raw cotton—then there is a probability that an induced spark might cause a fire. On the other hand it can be urged that raw cotton, being particularly liable to ignite spontaneously, furnishes a poor subject for a test case. There is certainly room for further investigation of the question.

AN IMPORTANT DECISION OF THE I.E.E.

It has been decided by the Council of the Institution of Electrical Engineers to appoint committees whose aim shall be to assist in the propagation of knowledge of recent work and progress in electrical engineering. We are glad to be able to report that the committee dealing with wireless telegraphy has already commenced its labours. The action taken by the Council should have beneficial and far-reaching effects, particularly as regards wireless telegraphy.

The following is a complete list of the members of the Wireless Sectional Meetings Committee (for Radiotelegraphy and High-Frequency Engineering) of the Institution: The President (*ex-officio*), Major E. A. Barker, M.C., R.E., Mr. Charles Bright, F.R.S.E., Dr. W. Eccles, Prof. B. W. O. Howe, Admiral Sir H. B. Jackson, F.R.S., Mr. W. Judd, Sir Oliver Lodge, Prof. E. W. Marchant, Dr. G. Marconi, Major J. Erskine Murray, R.A.F., Mr. J. Sayers, Major T. Vincent Smith, R.A.F., Mr. A. A. Campbell Swinton, F.R.S., Mr. J E. Tay'or, Capt. J. K. I. Thurn, R.N. (nominated by e Admiralty), Lieut.-Col. A. D. Warrington-Morris, O.B.E., R.A.F. (nominated by the Air Ministry), and Lieut.-Col. W. Ll. Evans, C.M.G., D.S.O., R.E. (nominated by the War Office).

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"Forward Wireless" in Battle

The Last Phase before the Armistice

By C. A. Oliver, Wireless Officer, 25th Division.

Continued from April Number, page 26.

THE result of this change in direction was to bring up the strength of signals three-fold, both of the signals received and those transmitted by the station.

The town of Landrecies fell to the British the following morning and from this time onwards the advance was more than twice as rapid as it had been hitherto. The enemy, however, still found time to blow up bridges, railways and roads and did all in his power to hold up the advance of the oncoming victorious hosts.

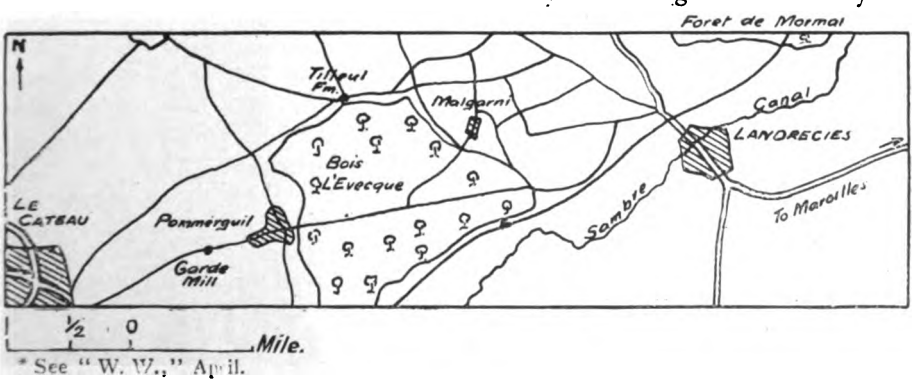
The Sambre canal was crossed by the advanced troops on improvised rafts and shortly after bridges were constructed by the Engineers under heavy shell fire.

That day saw a wirelessstation situated in Landrecies, communicating forward to positions between Landrecies and Maroilles. The first aerial erected at Landrecies was set up as shown in the photograph, No. 6,* and the lead-in wire run down to the cellar of the house. Later the aerial was swung round to point east and west and ran along the back of a row of houses, the aerial being supported from two upper windows.

The stations in front of Landrecies were moving rapidly from place to place but successful communication was always maintained with the rear station.

The civilian population in these parts was quite numerous. They had retired into their cellars while the battle had raged and passed over their heads and had afterwards emerged little if any the worse for the experience. Some were inadvertently killed but these were comparatively very few. Those who remained were most generously disposed towards the British troops and welcomed them with hot coffee as they passed by.

By November 6th the most forward of the wireless stations had advanced beyond Maroilles and on the same day the Landrecies station received orders to proceed to Maroilles and open up in the vicinity. Here again the enemy had



* See "W. W.," April.

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Wireless Station, Maroilles. *No. 7*

done all in his power to upset the advance by blowing up roads, bridges, etc. Some of the mines were discovered before they had exploded and the fuses of these were removed in time. At Maroilles the wireless station set up the aerial as shown in photograph No. 7, and at once gained touch with the forward stations which had been erected well to the east of Maroilles.

The Maroilles station was first erected after dark, the station itself being established in a room on the first floor of a chateau and the aerial being run out from an upper window of the chateau to a portable 15-feet mast erected in rear of the chateau. In the morning this arrangement was altered and the aerial run out in front of the chateau and stretched from an attic window to a tall tree in the vicinity. This arrangement gave the best results and is the one shown in the photograph of the Maroilles station.

About this time the diminished working of Bosch wireless was very noticeable. During the earlier stages his wireless had been most energetic, but latterly he became so disorganised and was moving back so rapidly that his communications must have become very scanty, if his wireless working was an indication at all. The quantity of wireless material and stores which the Germans were leaving behind them in their hurry to get away quickly, was ever increasing. Large quantities were found at Landrecies and again at Maroilles. This material consisted amongst other things of complete portable German wireless sets, accumulators, insulators, aerial wire and boxes of valves, also accumulator charging sets. At times he was able to destroy the main parts of these stores, but at other times he must have been hard pressed, for he left them intact.

On the other hand the British wireless communication was amply keeping pace with the advance, rapid though it was, and it bore well the great strain of work at times put upon it.

In front of Maroilles a wireless station

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W.T. Station near Taisnieres. *No. 8*

was erected south of Taisnieres and thence communication was established with Dompierre, a town still further forward. In selecting the site of the Taisnieres station much care had to be exercised on account of the extreme closeness of the country. The site selected was at a large farm house situated on fairly high ground, and the aerial was run out from an attic window to a 30-feet mast erected in a neighbouring field on the side of the farm nearest Dompierre. The station itself was on the ground floor of the farm. Between this station and Dompierre stretched a wide valley through which flowed a broad river—the River Helpe. On account of the valley wireless communication forward was made much easier than it would otherwise have been, as there were fewer natural obstacles in the way. The Taisnieres station is shown in photograph No. 8.

At Dompierre the wireless station was erected in a large chateau on the top of a hill just on the outskirts of the town. The aerial was run out from one of the top windows and stretched across to some stable buildings in the vicinity and belonging to the chateau. The Germans had only left the chateau a short time before the station was established there, but before leaving it they had made as big a mess of the furniture as they could, even going to the trouble of polluting it and defiling the tables, pianos and drawers of the cupboards. Why they did so is difficult to imagine, since it could do them no good and could only give them an ill reputation.

By this time the majority of the German wireless stations on this front had closed down, and there were extremely few to be heard working. As one Britisher remarked: "They must have been going back in trains" and indeed their retreat seemed almost to have turned into a complete rout.

The following day orders were received to establish a station at Trois Paves, a junction of three main roads about three miles north-east of Avesnes. This station was instructed to get in touch with a similar station at Maroilles.

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The station with its personnel arrived by motor transport as dusk was settling down and halted on the road junction, which, it was afterwards discovered, was mined in two places. The wonder was it had not already "gone up." However, the miners were at work on the task of rendering the explosives useless and before dark had removed the fuses from both mines. The wireless station was set up in a house on the northern road, some 300 yards from the road junction. The aerial was run out from a high tree near by, the far end of the aerial terminating on a 30-feet portable wireless mast erected in a field across the road. The station itself was placed in the upper story of the house. On account of the necessary long lead-in wire the aerial had to be greatly curtailed in length, but the additional height amply compensated for this and good reliable communication was quickly established.

What followed is now mostly public news. First rumours of the Armistice were mooted, then came the order for "cease fire" to give the German delegates time to pass through our lines; the order was originally given till midnight but was afterwards extended till 6 a.m. the next morning. Then followed strong rumours of the Armistice to take effect from 11 a.m., and later came the confirmation message over the wireless, and orders for the Trois Paves station to pack up and return. Though the station at Trois Paves was never actually required for any real serious work, wireless had already amply fulfilled its part, and had taken a noble share in the fighting up to the memorable 11th of November.

One cannot conclude this article without paying a tribute to the excellent work carried out by the men of the wireless service during the very trying conditions of the last phase of fighting. Often under the most adverse circumstances and under very heavy shell fire not one man shirked his duties, and it was untiring energy and loyal co-operation of all that enabled the wireless work to be carried through without a hitch in the last great battles before the Armistice.

Wireless Station, Trois Paves. *No. 9*

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Notes of the Month

THE AMERICAN NAVY AND THE WIRELESS COMPANIES.

WE notice with pleasure that during the Congressional hearing of the bill for Government control of wireless, Captain Hooper paid a fine tribute to the valuable services rendered to the American Navy by various manufacturers of wireless plant. Captain Hooper laid special stress upon his appreciation of the work done by Mr. E. J. Nally, vice-president and general manager of the Marconi Wireless Telegraph Company of America, which Company, he said, "more than anyone else suffered through what war brought upon them."

ANOTHER ASSOCIATION OF WIRELESS TELEGRAPHISTS.

We have been notified that in November, 1918, the Dutch wireless operators belonging to the staff of the Belgian Marconi Company of Brussels and the Telegraph Company "Radio-Holland" of Amsterdam have constituted the Vereeniging van Radio-Telegrafisten ter Koopvaardy (Association of Wireless Telegraphists of the Mercantile Marine) with headquarters at Westeinde 5/1 Amsterdam. The Board is composed entirely of members of the staff of these Companies, the Secretary being Mr. T. A. v. d. Vlies. The purpose of this Association is to further the interests of the operators by all lawful means in co-operation with similar Associations in other countries. The Association has been recognised by the Companies as representative of the operating staff.

SCIENCE MADE EASY.

From the *Electrical Experimenter* we copy the following choice sidelights on science:—

"You know when you hook up some plants in parallel that there enters a condition known as 'harmonics' that juggles the peak around and cuts it off, and goes negative when the generators are trying to make a positive impression on the line. Alternating current is great stuff and the guy that can get reactance and impedance kicking right and pull the wattless current off the line don't need to worry about such prosaic things as room rent and meal tickets. . . ."

"Speaking of wireless, Hertz looked over our heads and saw something we had overlooked since Galvani's 'return shock' on the frog's hind kicks. Then Marconi and others, notably De Forest, boosted the proposition along, so that now, with the audion amplifier, we transmit music, both chin and instrumental, for miles and miles on thin ether."

In fairness to our contemporary we must add that the article from which the above was extracted is entitled "Science in Slang."

CENSORSHIP OF TELEGRAMS.

The censorship of wireless messages to and from commercial coast stations, and vessels in West Atlantic and Pacific waters, has been abolished by the Canadian and U.S. Governments. Telegraphic traffic between the United States

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and Great Britain is now censored only in the country of origin.

WIRELESS RELIEF FOR CABLE SYSTEMS.

As there is still a serious delay on telegrams to and from India and the Far East, partly on account of broken cables and due partly to the unusually heavy traffic occasioned by the war, an auxiliary wireless service has been established between Great Britain and Egypt.

Also between the Isle of Man and England a wireless service is being organised, to take the place of the cable which is broken.

Marconi's Wireless Telegraph Company has offered to erect in Australia high-power stations capable of communicating with England and to establish a regular service between the two countries. Owing to the present delay and congestion of traffic this offer has been enthusiastically received by business men and the general public in Australia.

On account of telegraphic delays the Hong-Kong Chamber of Commerce is asking the Government to arrange for the temporary use of the naval high-power wireless station there.

COPPER LEADING-IN WIRES FOR VALVES.

A method of using copper or iron for the leading-in wires of electric lamps is described in the *Revue Generale de l'Electricite*. The wires are first oxidised on the surface and after being introduced into the glass are strongly heated. The result is that the oxide combines with the silicic acid of the glass, forming a silicate which is soluble in molten glass. The co-efficient of expansion of the wire and the glass are thus approximately equalised.

WIRELESS TELEGRAPHY ON FRENCH SHIPS.

The French Government has decreed that all French vessels of more than 500 tons gross displacement on which wireless apparatus was installed during the war must retain their installations for a period to be fixed by the Minister of Marine.

LLOYDS AND SENATORE MARCONI.

At a committee meeting which took place on April 9th, Senatore Marconi was elected an honorary member of Lloyds.

WIRELESS CLUB NOTES.

Amateurs resident in S.E. Essex are requested to write to Mr. Alexis J. Hill, 63, Strone Road, Forest Gate, E.7, with the view of forming a club.

A club has been formed in Plymouth under the name of the Three Towns Wireless Club, its present address being 7, Brandreth Road, Compton. Major The Hon. Waldorf Astor, M.P., has accepted the Presidency and Mr. J. Jerritt, the principal of the Bedford Park Telegraph Training School, has been elected Chairman. The Club will be run on social and instructive lines, the principal items of the programme being lectures and electrical demonstrations. The subscription has been temporarily fixed at 3s. per quarter. Readers desirous of joining are requested to communicate with the Hon. Secretary, Mr. W. Rose.

CORRESPONDENT WANTED.

Mr. P. Blancheville, 13, Rue Antoine Vollon, Paris, in order to improve his knowledge of English would like to exchange correspondence with a wireless amateur.

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The Amateur Position.

A Slight Improvement.

SCARCELY a day passes but we receive fresh evidences of the growing anxiety which exists amongst the amateur wireless workers of this country with regard to the possibility of state control. We have received a large number of letters on the subject, the tone of which affords a clear indication that the writers are men prepared to do serious work and to co-operate with the authorities in discouraging "fooling" in any form likely to be detrimental to official, commercial,—or amateur—radio working. The press, too, has paid a gratifying amount of attention to our arguments in favour of the abolition of the restrictions and up to the present we have not detected any note of opposition. The *English Mechanic* says:—

"We heartily endorse the campaign. Thousands of our own readers who, by their manifold contributions to our pages, did much to advance wireless telegraphy and promote fraternal co-operation, are impatiently demanding the removal of restrictions. Let them do their utmost to help all whom they can induce to send 'Dilly' and 'Dally' to the right-about."

D.O.R.A. BEGINS TO RELAX.

In a letter dated March 24th, the Secretary of the Post Office notifies manufacturers of electrical apparatus that it has been decided to remove the restrictions imposed on the sale of buzzers, which may now be sold without enquiries as to the use to which the purchasers propose to apply them. *The restrictions on the sale of thermionic valves remain unaltered, which means that at present the amateur cannot legitimately own or buy valves.* Spark coils, telephones, etc., may be purchased now on condition that the buyer gives a written undertaking that the apparatus will not be used in connection with the sending or reception of messages by wireless telegraphy except with the written permission of the Postmaster-General. Thus for the wireless amateur these concessions serve but little to relieve the situation; we hope, however, that we may regard them as the first of a series which will in the near future permit the independent worker to come into his own again.

"THE AMATEURS SAVED THE DAY."

Speaking before Congress during the hearing of the wireless control bill recently introduced—and dropped— in America, Captain Hooper said:—

"The amateurs saved the day when we had to man practically the entire merchant marine by naval radio operators in order to incorporate the merchant marine into the naval system."

In respect of war services rendered it is impossible to pay a higher tribute than this to any body of men, and although it would be an exaggeration to say that British amateurs saved the wireless situation when war broke out, we do know that but for the large number of them who hastened to the recruiting offices or to wireless training schools during the first few months of the war, the wireless services of the army, navy and mercantile marine would not have

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reached so quickly their high degree of efficiency.

What amateurs desire and ask for is nothing more than permission to resume their researches unhampered by any restrictions other than those which all reasonable men would agree to be essential to the regulation of traffic through the aether. By all means let wireless communications be regulated by laws and let private investigators of wireless bow to the priority claims of the public services; but these desirabilia can be attained without the entire prohibition of amateur-owned stations. If the present ban is not removed private aircraft will have to be navigated without the assistance of wireless telegraphy! That will be most encouraging to the pioneers of the British Mercantile Air Service.

We publish below a further selection of letters bearing on the whole question:

"SIR,—The control of amateur wireless could in my opinion be most effectively and economically regulated by granting experimental licences only to members of the various clubs (or societies).

"If an amateur interfered with a Government or Commercial Station it would be a simple matter to send a complaint to the Club and the latter could penalize the offender under its Rules (*e.g.*, abolish his transmitting powers) and if necessary recommend that his licence be cancelled. If the Club failed in its duty, all its members, or at least its committee's licences, could be suspended.

"Discipline could, and must be strictly enforced, especially in the vicinity of real stations.

"A disenfranchised (?) licencee trying to carry on with secret wireless would easily be traced down by local members.

"Not only would the suggested course be most cheaply administered, not only would delegated authorities stimulate responsibility (as is found in our best schools) but the interchange of ideas between members would be most helpful to all.

"Standard Rules could be formulated for all clubs, and the feared amateur nuisance scotched. (He was, by the way, frequently more of a nuisance to brother amateurs than to the regular stations.)

"There is another side to this question. Is it not a fact that electrical development in this country was most seriously hindered in the 'eighties by shortsighted bureaucratic control?

"The writer is under the impression that the Legislature gave Municipalities the right to buy up any local electric light or tram undertaking which might turn out well. Result, snug lethargic non-progressive jobs for some lucky electrical engineers, and capital and brains can take themselves away to where there is less control.

"As a preliminary step to the question why not collect the doings of amateurs in the war? To mention only one case it will probably be found that an amateur designed the most popular crystal amplifying valve attachment regularly used (unofficially perhaps) in the navy to-day, while the 60-guinea set it replaced is generally used as a convenient seat.

"Scores of other amateurs, whose keenness made them useful are now demobilised (dispensed with) and they are not allowed to study this most valuable life-saving science. It isn't cricket.

"Yours, etc.,

"SAGITTA."

"SIR,—Your article dealing with the future legislation of Wireless published in this month's WIRELESS WORLD touches upon a matter of great interest to those associated with Wireless, both commercially and scientifically. The question raised is one of national import-

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ance, and as such, deserves the interest and earnest consideration of all those having the industrial and economic welfare of our country at heart.

"There has, in the past, been a tendency on the part of the Government to place too much reliance on the recommendations of Government officials without fully investigating the possible consequences and obtaining the views of those interested on the commercial side. The times, however, have now changed, so that those of us knowing the attitude of the Government Wireless officials towards control, and realising how control as they understand it would affect the economic position, hold forth great hopes that the restrictions now in force will be repealed. Nothing less than the opportunities afforded in pre-war days to amateur investigation in this line of science will be satisfactory.

"The arguments of those favouring a continuance of the present control may be summarised under the following four headings:—

(*a*) Elimination of jamming.

(*b*) Secrecy.

(*c*) Practised control in case of an emergency when this may become necessary in the interests of the State.

(*d*) Increased facilities for public service.

"With regard to (*a*) the seriousness of jamming by amateurs and private investigators in this country in pre-war days has been very much over-rated. In point of fact it is doubtful whether commercial or Government stations have ever been interfered with to any extent by such jamming. It is generally realised, however, that some sort of legislation is necessary to cover the possibility of such interference occurring in the future. The practice in force before the war of issuing licences restricting those having private stations to certain limits with regard to power and wavelength was entirely satisfactory and should be resumed. It must be admitted that during the course of the war apparatus has improved to such an extent that the effective radius of a station of a given power has more than doubled, but the difficulties which this fact may seem to create are more than compensated for by the improved selectivity of present day apparatus. It may be found advisable to restrict the issuance of such licences to persons of a prescribed age having such technical knowledge as will enable them to intelligently interpret the language of the laws affecting their work.

"With regard to (*b*) the comments in your article are very much to the point. It would be a mistaken idea to suppose that any restriction however stringent would suppress the efforts of those who for any reason deliberately set out to intercept wireless messages in course of transmission.

"I would add that in the near future it should be possible to arrange a secret method of Wireless Communication to be used in cases where it is absolutely essential. In any case it is highly improbable that the interception by amateurs would cause serious embarrassment to any of the interests concerned.

"In respect to (*c*) it would not be a difficult matter for the Government to assume absolute control if at any time an emergency arose which would necessitate such steps being taken. It is difficult to believe that such an emergency will occur during the next decade.

"With regard to (*d*) increased facilities would not be afforded for public service should the Government assume absolute control.

"Experience in the past has taught us that the Government has lacked a good deal of enterprise in the matter of administrating its public Wireless Ser-

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vice. It is a fact, that in pre-war days messages could be sent to England at a cheaper rate through Wireless stations at Bergen in Norway and Scheveningen in Holland than through the medium of British stations. An instance of Government unfairness may also be found in the ruling that Shipping Companies should pay five shillings for the receipt of each message addressed to the commanders of their ships giving the state of the weather at coastal wireless stations, notwithstanding the fact that most of the larger class of steamers compile and transmit, free of charge, messages to the Meteorological Office in London giving them full particulars of weather conditions on the North Atlantic and elsewhere.

"The chief arguments against control apart from those dealing with the position of personnel may be summarised under three heads:—

(1) Hindering of development.

(2) Robbing wireless of the talent it would otherwise absorb.

(3) Prevention of competitive enterprise.

"With reference to (1) there is no doubt in the minds of those who have been associated with the development of Wireless, or of those interested in it, that to deprive amateur investigators of the facilities for experimenting which they hitherto enjoyed would seriously retard future progress. As Senatore Marconi so aptly stated in your columns Wireless Telegraphy had by no means reached finality in any of its branches and I think that the extent of progress in the future, as in the past, will depend in a large degree on the efforts of the independent and amateur investigators.

"With regard to (2) an article dealing with the future of Wireless Telegraphy published in the *Electrician* of February 21st says: 'It may be contended that inventions of the first class are the work of a few exceptional men. This is true, but the point is, that if widespread education is not encouraged these exceptional men are never produced, or at least their gifts are never deflected into the channel in which they might be peculiarly useful. Education in this sense means, not merely book-learning; contact with apparatus, and the struggling with experimental difficulties are infinitely more essential.'

"This point has been very clearly illustrated during the war. Professional Wireless men in the Services have been surprised at the keenness and ability of the amateurs who so patriotically came forward to fill the demand for Wireless personnel. When these men return to their civilian occupations they will rightly contend that their services have entitled them to a large amount of consideration in regard to their Wireless activities. Universities and other educational institutions in this country will do well to follow the lead of America in the matter of creating a keen interest in Wireless among their students by having up-to-date Wireless Apparatus installed in their laboratories.

"With regard to (3) there is no doubt that to eliminate entirely private competitive enterprise would act very much against national interests. To quote again from the article in the *Electrician*: 'No amount of liberty for established firms could compensate for the extinction of the independent worker; in fact, this extinction would assist these firms to become great monopolies.' It is a matter of great doubt whether in view of the force of public opinion it will be advisable to exercise any form of drastic control which would eliminate entirely the Wireless amateur.

"Yours, etc.,

(Signed) "RONALD FERGUSON."

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Practical Notes on the Use of Small-Power Continuous Wave Sets

BY J. SCOTT-TAGGART, M.S.BELGE E., A.M.I. RADIO E.

Continued from April Number, page 46.

IN order to measure continuous-waves accurately it is necessary to have a graduated miniature receiving circuit in which persistent oscillations are taking place. The design of such a wave-meter has been already fully discussed by the writer,* but as such an apparatus is essential to the working of C.W. sets, a short explanation will not be out of place.

Fig. 2 shows a simple arrangement, consisting of a reaction coil *R* and a plate oscillatory circuit composed of the lower half of the same coil shunted by a variable condenser *C*. In the plate circuit is a small high-tension battery of about 40 volts, and a pair of low-resistance 'phones. By means of *S* the filament current may be switched on, and the system made to oscillate continuously on a wave-length depending on the value of the variable condenser *C*. The softer specimens of hard valves generally work best on such a wave-meter.

If the key *S* of the transmitter be depressed, and the heterodyning wave-meter brought within range, the waves emitted will set up oscillations in the

* *Vide* "The Measurement of Continuous Waves," THE WIRELESS WORLD, October and December, 1917.

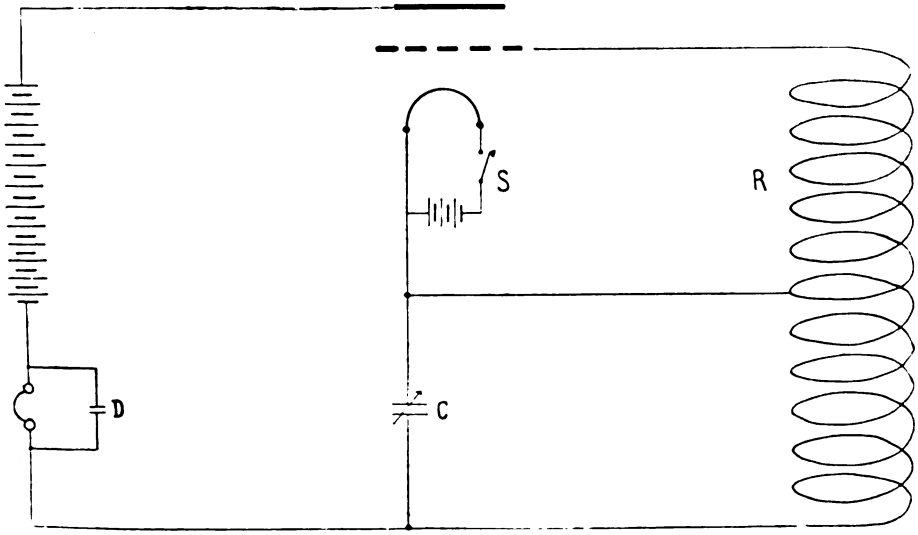

Fig. 2.

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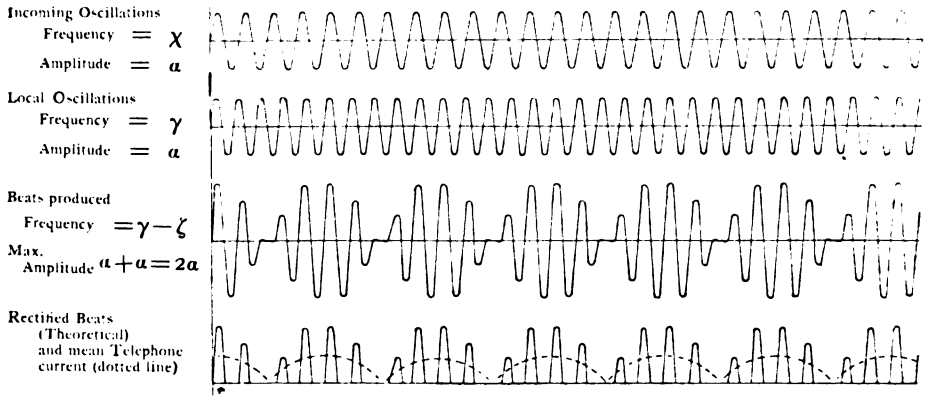

Fig. 3.

wave-meter which will combine with those already taking place. Suppose the instrument is brought up to a set which is sending out waves of, say, 800 metres length. These waves will have an interference effect on the oscillations already taking place in the wave-meter. If the wave-meter is set to, say, 750 metres, the system will be oscillating at a frequency of 400,000. When the wave-meter receives the 800-metre continuous waves, oscillations of 375,000 frequency are set up in addition. These two sets of oscillations, superimposed upon each other, will produce a resultant oscillating current with beats when the two sets of oscillations are momentarily assisting each other. The frequency of these beats will be equal to the difference of the two separate frequencies, and will in the present case be 25,000.

The valve is also acting as a detector in addition to generating oscillations. The beats, therefore, are rectified, and will produce in the telephone receivers a note having a frequency equal to the beat frequency. This note, to be audible to the human ear, must be below a frequency of 14,000. It is obvious, then, that if the wave-meter be set to 750 metres, nothing whatever will be heard in the 'phones. Only when the wave-meter condenser is turned round till 770 metres is reached will anything at all be heard in the ear-pieces, and then only an exceptionally high note. As the wave-meter condenser is turned nearer to 800 metres—*i.e.*, as the two

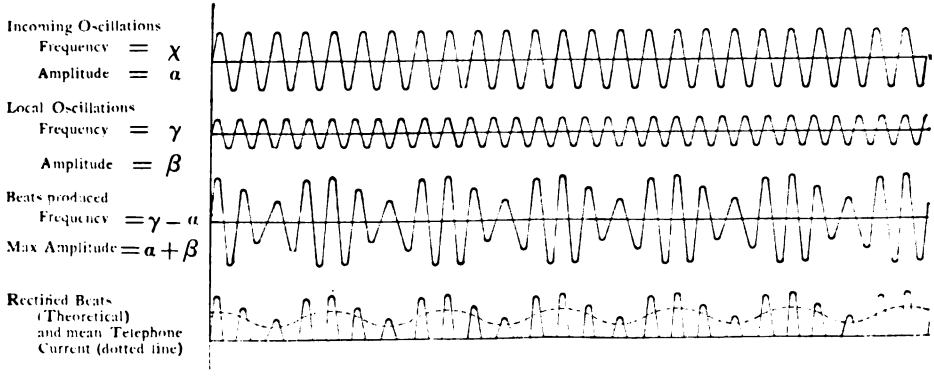

Fig. 4.

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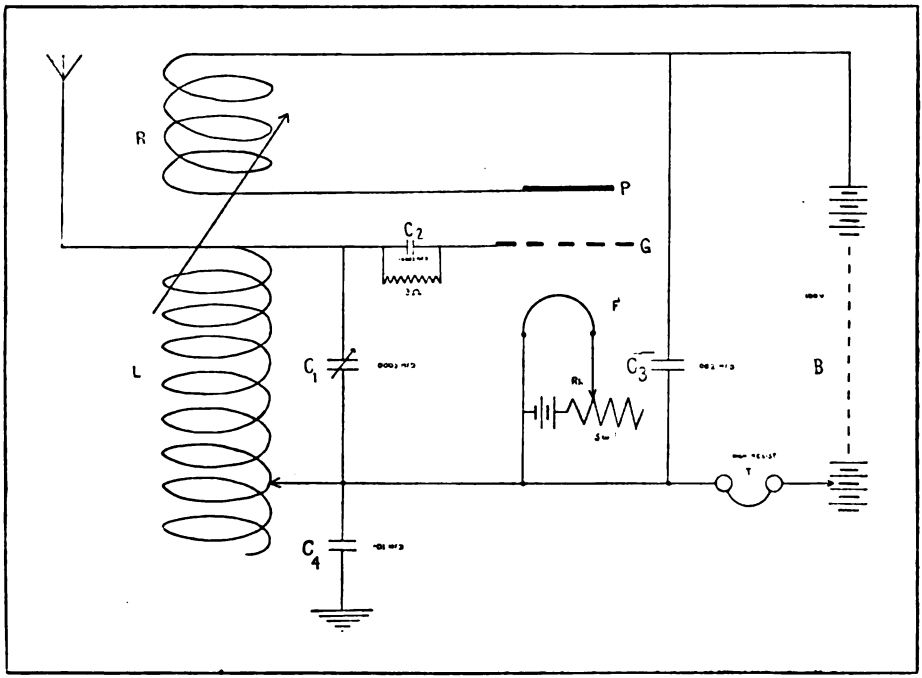

Fig. 5.

frequencies approach each other—the note in the telephones gradually gets lower and lower till, at 800 metres, nothing whatever is heard. The two frequencies, local and superimposed, are now identical, and, whether in phase or not, produce resultant oscillations of constant amplitude, and which therefore are unable to affect the telephones, even when rectified.

As the condenser of the wave-meter is gradually turned further round to wave-lengths higher this time, than 800 metres, beats begin to be formed, and a low note is heard which gradually gets higher as the condenser is turned, until at 830 metres the note gets so high that the ear can no longer hear it.

It is therefore seen that if the wave-meter is over 30 metres " out " on either side, nothing will be heard at all.

From the above consideration it will be seen that, in order to measure waves of an unknown length, it is only necessary to turn the wave-meter condenser round until a " chirp " is heard. This " chirp " when analysed consists, as described above, of a high note, gradually getting lower till nothing is heard, and then rising from a low note to a high one again. The wave-meter is adjusted to the middle part, so that, which ever way the condenser may be turned, a note will be heard which rises higher and higher. The reading on the wave-meter will now give the wave-length required.

Very misleading results are often obtained by having the wave-meter too near the set or aerial. Frequently the fundamental wave is too strong and produces little and sometimes no effect in the telephones. On the other hand, complications arise owing to the weak harmonics generated in addition to the fundamental waves. These harmonics frequently produce much louder " chirps " than the fundamental waves when the wave-meter is too close

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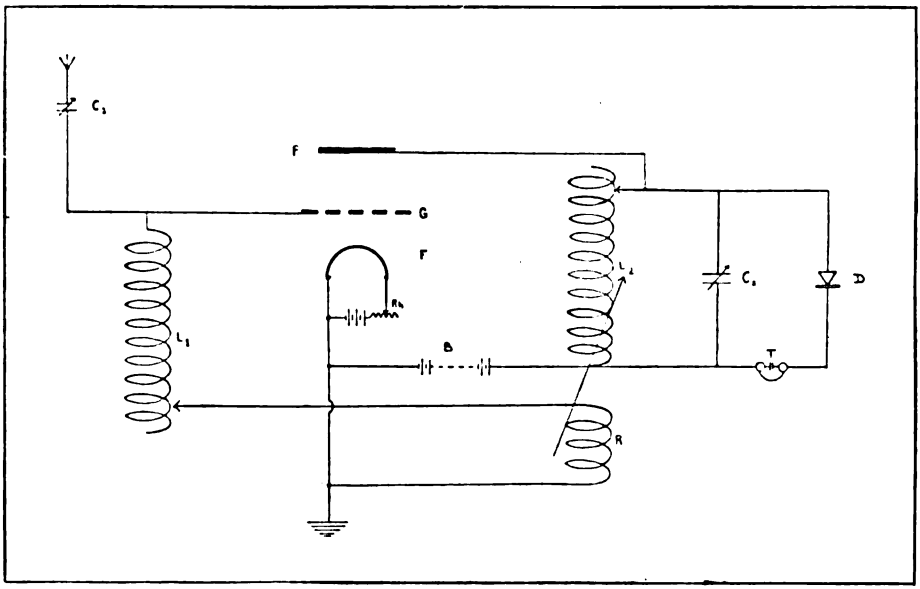

Fig. 6.

to the instrument, and so may give rise to incorrect assumptions. At a distance, though, these harmonics are too weak to influence the wave-meter, which will then only respond to the real fundamental waves. It would be as well, perhaps, to point out that it is not sufficient to move the wave-meter alone away. The telephones and the operator wearing the receivers should also be at some distance from the instrument. Fig. 3 shows an example of what takes place in a wave-meter circuit. When the incoming oscillations are equal in amplitude to the local oscillations. Fig. 4 shows the effect of having local oscillations weaker than the incoming ones. Less accurate results are obtained, harmonics are frequently measured by mistake and the "silent interval" is too long.

II

RECEPTION

Let us now consider the receiving station. Fig. 5 shows a typical circuit suitable for the reception of continuous waves. Figs. 18 and 19 of the writer's Paper* on "The Valve as an Amplifier" (Part iii) also show simple circuits for the same purpose. They are reproduced in Fig. 6 and Fig. 7.

In Fig. 5 the aerial tuning inductance is connected across the grid and filament of a valve. The inductance is shunted by a condenser C, which is used for obtaining fine tuning. C_1 is a blocking condenser of .01 mfd. in series with the by a resistance of several megohms; a suitable resistance consists of a few earth. C_2 is a small condenser shunted pencil lines on a sheet of ebonite. This leaky condenser makes the valve more efficient as a rectifier, although good results may be obtained without it.

In the plate circuit of the valve is an aperiodic reaction coil R. and a high-tension battery B variable by means of plugs to give any voltage up to about 100 volts, and a pair of high-resistance 'phones T. A small blocking condenser C_3 is placed across the 'phones and high-tension battery; this condenser does not affect the tuning of the plate circuit, but affords an easy passage for oscillations

* *Vide* THE WIRELESS WORLD, March, 1918.

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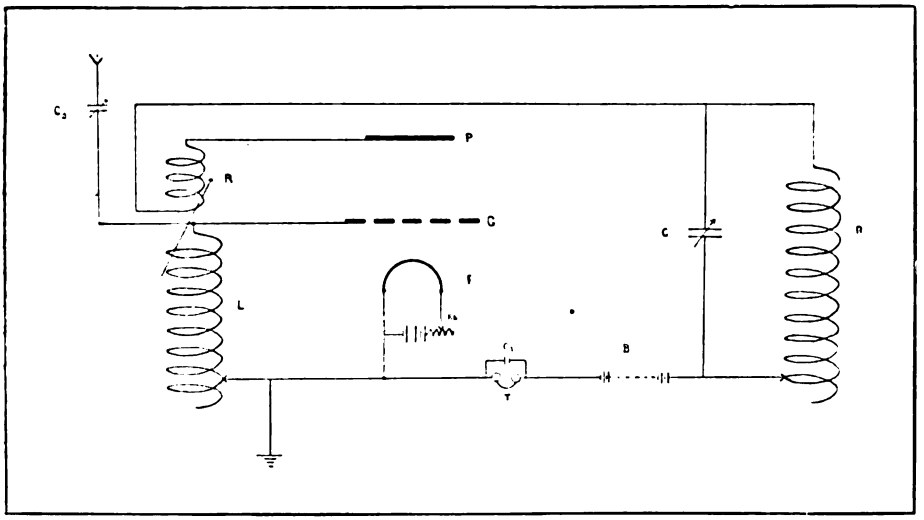

Fig. 7.

taking place in the circuit. Instead of using high-resistance 'phones, the high-resistance primary of a step-down transformer is preferable, a pair of low-resistance 'phones being connected to the terminals of the secondary. The advantage of this arrangement is that the main steady-plate current does not pass through the 'phones, and therefore there is no chance of them being demagnetised through being connected the wrong way round, or being injured by a break down of their insulation. Moreover, there is not the same chance of the operator receiving shocks, since no current passes through the 'phones except when signals are being received and the main plate current is varied.

The filament of the valve is heated by a four-volt accumulator. *V* is a variable resistance for varying the value of the filament current, and is preferably a spiral of resistance wire fitted with a sliding contact in order to vary the current smoothly. Its resistance is 5 ohms.

Before tuning in, it is necessary to see that the valve is oscillating on approximately the adjustment on which it is intended to work. There are several ways of telling when the set is in a condition to receive continuous-wave signals. When the valve is oscillating all spark signals heard are very hoarse, no matter what their real spark-frequency may be. On touching the aerial terminal a sharp click should be heard. If the aerial tuning inductance is variable in studs, clicks should be heard when the switch is moved across the studs in use. Also, if the condenser C_1 shorts when moved to 0° or 180°, clicks will be heard at these positions. If none of these effects are noticed, the valve is not oscillating, and is therefore not in a position to heterodyne incoming continuous waves.

(To be continued in June number.)

SHARE MARKET REPORT.

Business in the shares of the Marconi group have been very active during the past month. The shares of the International Marine Company show a marked advance in price due to the new issue which constitutes a large bonus to the shareholders. The prices as we go to press (April 14th) are:—Marconi Ordinary, £4. 18. 1¼; Marconi Preference, £4. 2. 6; American Marconi, £1. 9. 6; Canadian Marconi, 15s. 6d.; Spanish and General, 14s. 6d.; Marconi International Marine, £4. 13. 9.

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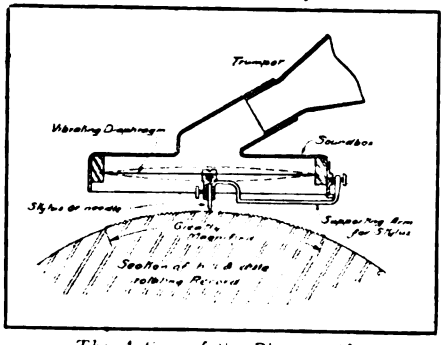
The Wireless Telephone and the Evolution of Speech Transmission

By J. J. Honan.

THE PHONOGRAPH.

IN the case of the phonograph, the air vibrations which give rise to "speech-sounds" are caused by the oscillation of a diaphragm by mechanical means, namely, the traversing by a needle point of the hill-and-dale or similar tracings on the ebonite record. The consequent oscillatory motion of the needle is transferred to the diaphragm, thereby setting the adjacent layer of air into the particular form of air wave-motion, which, impinging on the human ear, is interpreted by the brain as speech.



The Action of the Phonograph.

In preparing the record, the reverse operation is performed. By speaking on to a diaphragm to which a needle is attached, the pointed end is caused to score the soft wax mould with speech-form serrations, which are preserved in the hard ebonite records that are cast from the mould. In both cases, air is the medium which conveys the sound to or from a mechanical device which registers the wave form in facsimile.

THE LINE TELEPHONE.

In the case of the ordinary line telephone, the initial and end operations are similar, but a magnet is employed in place of the phonograph needle to transfer the effects between the diaphragm and the recording means, which in this case is also the medium of transmission, viz., the electric current.

Speech-form air vibrations impinging upon the telephone diaphragm cause it to vary the normal magnetic flux in a magnetic circuit (comprising a horseshoe magnet and the telephone diaphragm) by increasing or diminishing the distance between the diaphragm and the poles of the magnet. This variation of magnetic flux reacts inductively upon the line circuit between the receiver and transmitter, because a portion of that circuit passes around the magnet. As the magnetic flux is increased or diminished, the normal electric current flowing in the line circuit rises or falls according to the well known law of electromagnetic induction.

The variation in the normal line circuit so set up is of course repeated at the receiving end of the circuit, where again the line wire passes around the legs of a horse-shoe magnet, provided with a metal disc or diaphragm in close proximity to its poles—identical with the transmitting arrangement. Here, however, the increase or decrease of the current sets up a corresponding variation in the magnetic flux springing from the magnet, the result being that the diaphragm is pulled towards the magnet with a varying force which follows exactly the fluctuations of the circuit current. In this way the receiving diaphragm is vibrated, and as the initial variations "poured" into the transmitter

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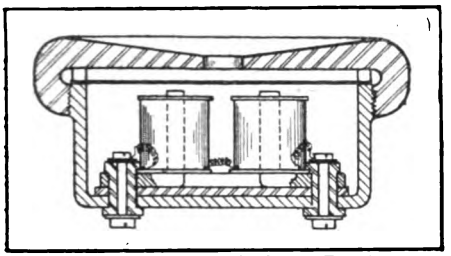

Section through Telephone Receiver.

are exactly reproduced, the layers of air adjacent to the receiving diaphragm are set into identical speech-form vibrations, which thence spread outwards through the air until received by the ear.

THE WIRELESS TELEPHONE.

The wireless telephone may be similarly comprehended with some difference in detail. The primary distinction is, of course, that no wire exists to carry the electric current and any variations that may be imposed upon it.

This difficulty disappears when one realizes that the main difference between the electric current carried by a wire and the electric disturbances conveyed by means of ether waves is one of form rather than of quality. Both represent the transfer of electric energy propagated at identical speeds, and both are capable of producing "end effects" of a similar nature upon suitable receiving-devices. In the case where the passage of electric energy takes place along a wire it is confined, practically speaking, to the path of that wire; whereas in the case of ether waves the electric energy spreads outwards from the source equally in all directions, *i.e.*, the distribution of energy is that of a sphere with the originating point in the centre, and the outer boundary limited only by time and infinity—the "borders" of which it approaches at the rate of approximately 186,000 miles per second.

Keeping these distinctions in mind, then, for the transmission of speech without wires we must first reproduce the equivalent of the steady circuit-current in the case of the ordinary phone. This is done by means of suitable electrical apparatus, such as an oscillating valve or Poulsen arc, which sets the adjacent layers of ether into a state of steady sustained electric vibration at a definite frequency and with a definite amplitude.

In the case of the valve, one of the factors producing and determining this steady state of ether vibration is the value of potential applied to the sheath of the valve. So long *cæteris paribus* as that potential is maintained as a fixed steady value, the amplitude of the ether waves generated remains constant.

At the receiving end is a very similar "detector" valve. So long as this detecting-valve receives only the steady ether vibration, it produces in a certain part of its attached circuit a constant electric current which does not affect the phones. Here we have the same condition of things that exists in the ordinary line phone before it is spoken into.

The next step is to impose upon this steady condition a periodical variation which shall exactly follow in frequency and quality those alternations of air pressure which we know as speech.

Attached to the transmission valve is a circuit containing a microphone, which is nothing more nor less than a slightly modified telephone transmitter.

The effect of speaking into the microphone is to vary the steady value of the electric current flowing in its circuit in exactly the same manner as in the case of the line wire phone. In other words oscillations in current value are set up which correspond in their alternation to the speech-form variations causing them.

These current disturbances are enhanced by means of a "control" valve, and are then converted by a choke-coil into exactly similar variations of electric potential. The latter are finally applied to the before-mentioned sheath of the oscillating "power" valve, and being

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superimposed upon the existing constant potential (applied there from a separate source), thereby cause the steady wave output of ether vibrations to be varied *in amplitude* in a precisely similar degree.

The disturbance caused by the speech-form vibrations poured into the microphones have therefore now been translated into analogous variations in the form of the ether waves that are speeding through space towards the receiver. It will be remembered that these variations exist in the form of alternations of amplitude. But amplitude is a measure of the amount of energy contained in the ether vibrations, so that when they impinge upon the receiving-device, instead of creating a steady current in the associated circuit, currents of varying strengths are set up corresponding to the varying amounts of energy (*i.e.*, wave amplitude) received. These varying currents, passing around the magnets of a pair of phones, operate upon the telephone diaphragm to pull it with varying degrees of force, and thereby set it vibrating in such form as to reproduce the exact variations that caused the initial disturbance to the state of electric equilibrium at the transmitting end (*i.e.*, speech into the microphone). These disturbances are in turn communicated to the adjacent layers of air and so reach the ear as speech.

And thus distance is annihilated and the apparently impossible converted into an accomplished fact.

DEATH OF SIR WILLIAM CROOKES

It is with great regret that we record the death at the age of 86 of Sir Wm. Crookes, O.M., F.R.S., which occurred on April 4th at his residence in London. This great man who was born in London in 1832, and who has left an indelible mark upon every department of science in which he engaged, was first and foremost a chemist. After working under Hofmann he became in 1834 the superintendent of the meteorological branch of the Radcliffe Observatory, Oxford, and in the following year lecturer in chemistry at Chester Training College. Shortly after this he came to London, where he lived for the remainder of his days. He discovered Thallium, did much valuable work in connection with radioactive substances, founded and edited *The Chemical News*. and published an enormous amount of work relating to chemistry, both pure and applied.

Following up the researches of Plucker and Hittorf on electric discharges through rarefied gases, Crookes propounded the theory, which more recent physics confirms, that cathode rays consist of material particles which are emitted with great velocity in a direction normal to the surface and traced in straight lines, and he stated that their deflection by a magnetic field is owing to the fact that they are negatively charged. Here we have the foundation of the modern electronic theory. The charge carried by a particle of Crookes' "radiant matter" has been measured by Sir J. J. Thomson and is now adopted as a natural electrical unit. A determination of the mass of the particle has shown that the electron is of ultra-atomic dimensions.

Sir Wm. Crookes who received his knighthood in 1897 has been the recipient of almost every honour coveted by men of science. These include the Fellowship of the Royal Society, the Royal Medal, the Davy Medal, the Copley Medal, the Order of Merit and the Albert Medal of the Society of Arts. With his death there has passed one of the few remaining survivors of the band of eminent men who helped to make the Victorian era so serviceable to humanity.

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Aircraft Wireless Section

Edited by J. J. Honan (late Lieutenant and Instructor, R.A.F.).

These articles are intended primarily to offer, as simply as possible, some useful information to those to whom wireless sets are but auxiliary "gadgets" in a wider sphere of activity. It is hoped, however, that they may also prove of interest to the wireless worker generally, as illustrating types of instruments that have been specially evolved to meet the specific needs of the Aviator.

AIRCRAFT WIRELESS SETS.

I—The Sterling Transmitter.

GENERAL DESCRIPTION.

THIS little spark set has been without doubt the most widely used of the many service wireless installations during the war. It is a well-designed efficient instrument, very compact, and takes up but little space in the bus.

Diagrammatic sketches of the set are shown in Figs. 1, 2 and 3, the same lettering being used to indicate similar parts in all three diagrams.

The dimensions of the box are roughly 8-in. by 8-in. by 5-in.

On one face is mounted a spiral or helix of metal ribbon forming the closed-circuit inductance, the free end being at the centre. Two leads make adjustable connection with the helix; one F^1 coming from the centre is the closed-circuit tuning-clip; whilst the other K^{11} is the coupling-clip.

The spark gap 3 is housed within the top right-hand side of the box, the width of the gap being adjusted by means of the side screws shown. The make-and-break is arranged just below the spark gap and is also adjustable. This side of the box is hinged so as to allow access to these parts of the set.

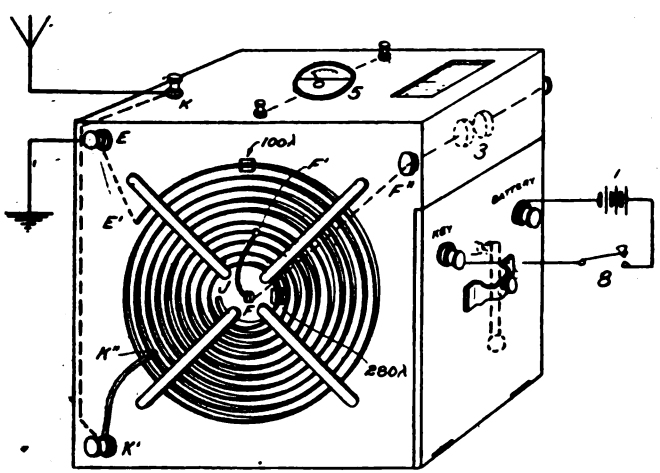

Fig. 1.

On the exterior of the same side are

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placed the key and accumulator terminals. A hot-wire ammeter 5 is mounted at the top of the set, and the aerial and earth terminals E, K are as shown.

The set is essentially for short ranges only. With a crystal detector and fair atmospheric conditions it proved efficient up to 20 miles between plane and earth; but this distance could be considerably increased under conditions more favourable than those of active service, and with a more efficient kind of receiver than a crystal detector.

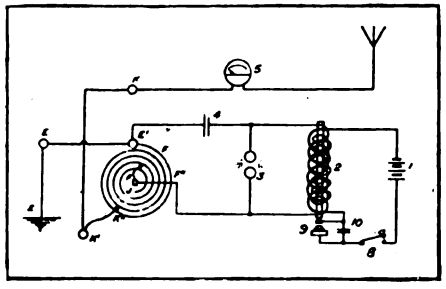

Fig. 2.

In fact, within a specified limit of short-range work it forms a type of transmitter that is capable of very successful adaptation to the wireless needs of commercial flying.

The ordinary service set as illustrated was designed for transmission on wavelengths ranging from 100 to 300 metres.

CIRCUITS.

The transmitter is best considered as consisting of the following simple circuits:—

I—The primary circuit comprises three 2-volt accumulators, the key 8, and primary of the induction coil 2.

II—The secondary circuit comprising the secondary of the induction coil, a part, namely F^1E^1, of the helix inductance, and the condenser 4, which, when it becomes charged from the induction coil to a sufficient voltage breaks down the spark gap 3, thereby forming a *new* circuit viz.:

III—The closed oscillatory circuit consisting simply of the portion F^1 E^1 of the helix inductance and the condenser 4 now connected by the new path opened up through the spark gap. It is in this last circuit that the high-frequency oscillations are first generated. The portion K^{11} E^1 of this circuit is also common to—

IV—The open or radiating circuit, consisting of the aerial K hanging down below the bus, the part $K^{11}E^1$ of the helix inductance through which the transfer of energy from circuit III takes place, and the earth lead which connects with the engine and metallic parts of the bus.

ACTION OF THE SET.

The current flowing in the primary circuit is interrupted by the "break" 9, thereby inducing high voltages across the terminals of the secondary winding of the induction coil. These charge up the condenser 4 to a corresponding value, and at the same time are sufficient to break down the dielectric at the spark gap, thereby providing a path for the condenser to discharge through the portion of the inductance F^1E^1 that is included in its circuit. This initial discharge, owing to the "inertia" action of the inductance "overruns" itself and charges up the other plate of the condenser so that the next flow of current is in the opposite sense and so on. The high-frequency oscillation thereby set up continues so long as the persistence of the spark affords a free path for the surging current.

Actually in the set, the current passes and repasses the gap path from 30 to 40 times during the life of each spark.

During the passage of each surge of current through the portion $K^{11}E^1$ of the helix there exists a periodic back e.m.f. due to induction, which is free to

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act along the condenser circuit formed by the aerial and earth.

This open circuit, being duly tuned to the frequency of the current surges in the closed or spark-gap circuit, reacts

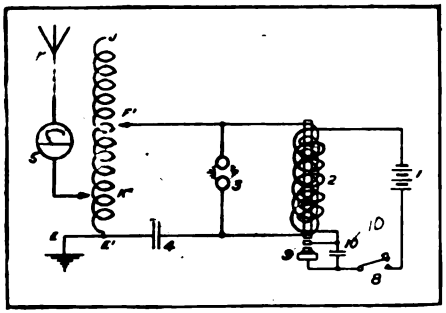

Fig. 3.

readily to the periodic impulses so applied, and a high value of current is rapidly established, oscillating between aerial and earth, and reacting upon the surrounding ether to produce those alternating disturbances of electromagnetic equilibrium which are radiated as ether waves.

TUNING THE CLOSED CIRCUIT.

As will be seen from the diagrams, the open and closed circuits are auto-coupled, the portions $A^{11}E^{1}$ of the spiral inductance being common to both circuits.

The tuning of the closed circuit presents no difficulties. The spiral inductance has been tested and calibrated by the manufacturers, and the tuning-clip F^{1} is therefore simply connected to the helix at the correct position as indicated by the scale.

The fixed condenser in the set under discussion has a value of .0025 mfds., and the variable inductance is so calibrated that the clip when fixed at say 200 metres on the scale thereby determines the L.C. value of the circuit so that it oscillates at the correct frequency to give this wavelength.

The clips used are of the form shown in Fig. 4 and straddle the helix ribbon as indicated. They are somewhat troublesome to manage at first, and are

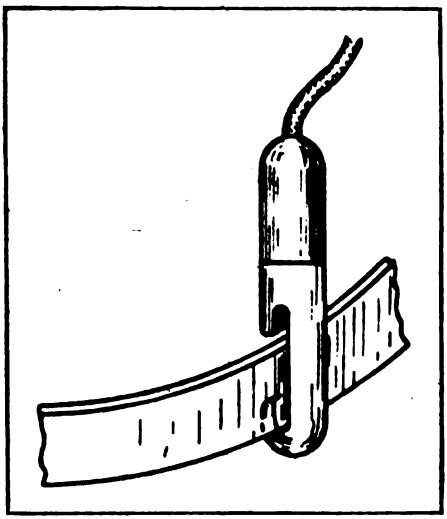

Fig. 4.

rather liable to become displaced under vibration when in the air, so that it is well to have an eye upon them from time to time.

(To be continued.)

WIRELESS ON TRAWLERS.

We learn that the demobilisation of mine-sweeping trawlers is duly proceeding, but that whilst the authorities seem to lay no claim to the paint composing the camouflage of these boats, they have dismantled the wireless installations, and the point is raised as to whether it would not be a sound plan to fit a certain number of trawlers in each fleet with wireless so that they could supply the fishermen with information regarding the state of the markets and so on. There is certainly a great deal to be said in favour of this. The country owes the men who work these vessels a heavy debt on account of their great services during the past four years of mine-fishing, and any practicable arrangement making for their convenience and prosperity ought to receive proper consideration.

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Aviation Notes.

THE TRANSATLANTIC FLIGHT.

PREPARATIONS for the great attempt are being rapidly pushed forward. The adverse weather conditions of the early Spring will add a further strain to the already severe test of endurance both for pilot and machine, represented by an uninterrupted flight of over two thousand miles even under the most ideal conditions. Nevertheless from the eager spirit of rivalry displayed it appears that the start will not be much longer delayed.

The following is a list of competitors as at present announced:—

TYPE.	H.P.	M.P.H.	PILOT.
Fairey ..	375	120	Mr. S. Pickles
Sopwith ..	320	100	Mr. H. G. Hawker
Whitehead ..	1600	115	Capt. A. Payze
Short	350	95	Maj. J. C. P. Wood
Handley-Page	1600	110	Lt.-Col. Collishaw
Curtis Seaplane	440	—	Capt. H. Sundsted
" "	—	—	Lt.-Com. Bellinger
Martinsyde ..	285	100	Mr. F. Raynham

One of the big Italian Caproni machines will also probably be a starter.

It is understood too that, in spite of reports to the contrary, the R.A.F. intend to try their luck with the giant Porte triplane flying-boat, which is to be shipped to Newfoundland and flown back.

Various routes are favoured by different competitors. The most "sporting" and of course the most risky is the practically straight non-stop flight from St. John's to the South-west of Ireland — approximately 2,000 miles. One alternative is a non-stop run from Newfoundland to the Azores (1,400 miles) and thence via Lisbon (900 miles) to England (1,000 miles). Another suggestion is to take a more Northernly path with breaks at Greenland and Iceland. One pilot—Major Wood—proposes to make the passage Westwards, starting from Limerick.

All the machines will of course be fitted with wireless sets and most of them will depend to a large extent upon direction-finding wireless in steering their course, obtaining their bearings in this way from "beacon" ships located at intervals *en route*. This will enable them to compensate for "drift" more accurately than is possible by any other known means—particularly over the sea where "landmarks" are very few and far between.

Possibly in our next issue we may be able to acclaim the winner; and within a few years—without detracting one iota from the initiative and pluck of the present pioneers—it will probably become our habit to regard the feat as a commonplace and everyday occurrence.

THE CONTROL OF CIVIL AVIATION.

Now that Major-General Sir F. H. Sykes has been appointed Comptroller-General of Civil Aviation we may shortly expect to be informed as to the general line of policy to be taken by the new Department.

No doubt this will fall roughly under three main headings:—

(1) Planning the main arteries of aerial traffic, and arranging questions of international policy to the best mutual advantage.

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(2) Setting up the necessary chain of aerodromes and meteorological and wireless stations—*and staffing them!*

(3) Drafting a code of air laws to govern the conduct and procedure of aerial traffic generally.

Divisions (2) and (3) involve many points of interest to those who follow wireless as a career. For one thing it is practically certain that all aircraft will be compelled to carry wireless installations, not only for their own protection in cases of emergency, but also for purposes of control by the Customs, Police, and other authorities.

It is already the law at sea, and there is even more necessity in the case of aircraft.

This, in combination with the necessary co-operating land and sea wireless stations, opens up for the future a considerable field of activity and scope for the wireless engineer and operator.

NAVIGATION BY DIRECTION-FINDING APPARATUS.

A considerable amount of misconception still exists as to the precise value of D.F. sets as a means of locating positions in the air.

There are two principal ways of using the radiogoniometer or direction-analyzing receiver.

The first is to instal it on land and use it to analyze the direction of origin of signals transmitted from a plane—in other words to find the "bearings" of the plane from the receiving station. The station then transmits this information back to the lost wanderer. If this is done by two land stations whose location is known by their code call, the pilot can by means of his chart rapidly re-locate himself with sufficient accuracy.

This method has the advantage that the analyzing work of the radiogoniometer is done on land and under the most favourable conditions for ensuring the greatest sensitivity and accuracy. The drawback is that the range of usefulness is limited by the *transmitting range of the plane* which at present is relatively restricted.

In the other arrangement the radiogoniometer is installed in the plane and may be "swung" to take the bearings of high-powered land stations such as Poldhu and the Eiffel Tower.

Even with the unfavourable conditions existing in the air—so far as receiving is concerned—the range of usefulness with the latter arrangement is many times greater than with the first. Magneto-noise trouble has practically been eliminated, the cascade-valve sets give remarkable sensitivity, and the calculations necessary to interpret the bearings are reduced by specially-prepared charts to a mental level but little removed from that involved in calculating how many beans make five.

The latter point may have some soothing effect on those who find a nervous pleasure in "crabbing" anything that smells of wireless on the excuse that it introduces unnecessary and wearisome complications to the business of flying.

RADIOPHONES OVER LONDON.

The daily newspapers created a considerable stir about the middle of last month over a little practical illustration of the possibilities of wireless telephony from the air.

The occasion arose from the visit of a flight of planes fitted with telephony sets, and their indulgence in pleasant converse whilst manœuvring over the precincts of Leicester Square.

This was duly appreciated by the operators at the various Government wireless stations in and about town, who promptly "tuned in" and listened.

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It was by no means the first event of the kind, but apparently Fleet Street was let into the game on this occasion and made hay accordingly. So now we know that it *can* be done, and that the peevish language and hiatused Limericks that have, from time to time, filtered through our phones when up aloft were *not* the psychic voices of aerial spooks, nor yet the creations of an over-ripe imagination.

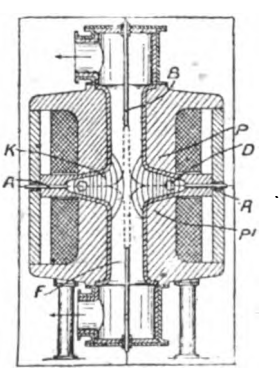
The departure from the precise phraseology set out in the official "book of words" supplied for the guidance of transmitters must be attributed to some obscure ether-wave reaction not subject to the penalties laid down in King's Regulations.

Patent Section

Under this heading will be printed each month abridgments from the Illustrated Official Journal (Patents) of wireless patents recently published.

122,173. Electric currents, generating electric furnaces. Petersen, C. 25, Bogstadveien, Christiania. December 30th, 1918, No. 21811. Convention date, January 8th. Not yet accepted. Abridged as open to inspection under Section 91 of the Act. (Classes 1 (ii) 35, 39 (iii) and 40 (v).)

Current is generated by forcing gases to rotate in a magnetic field, and may be utilized externally or may effect reactions in the gases. Oscillatory currents for wireless signalling and the like, may be produced. As shown, the gas is blown into a circular chamber *K* through tangential inlets *D*, and escapes by one or two axially-arranged passages *F*, the gas currents may, however, be reversed in direction Pole-pieces *P*, *P*^{1} of an electro-magnet are situated on opposite sides of the chamber. Radial electrodes *A*, or an annular electrode, and axial electrodes *B*, which may be in contact, are provided; the walls of the chamber may also form an electrode. The negative electrodes emit ultra-violet rays under the action of ionic bombardment, thus promoting ionization. Initial ionization may be effected by quartz lamps emitting ultra-violet rays; or the electrodes may be initially or continually supplied with high-pressure current. By the use of an alternating magnetic field, or of a multipolar arrangement, alternating current may be obtained. The chamber may be higher and the field radial; a central iron block may be provided. If gas reactions are to be effected, electrodes may be dispensed with, or employed as auxiliaries only. The gases may be air, steam, or combustion products. The pressure for forcing them into the chamber may be produced by combustion of coal gas, oil, or the like in a closed vessel; or combustion may take place in the chamber itself. For producing nitrogen oxides the gas may contain



an excess of air, or the oxygen may be obtained by decomposition of the carbonic acid or steam. The combustion air and fuel may be pre-heated by the gaseous products, and the air may be led around the apparatus. Most of the heat of combustion may be used for raising steam, burning tiles, and other purposes. Ammonia may be prepared from a mixture of steam and combustion gases. The electric current obtained may be used for magnetization and for compressing the gases.—*Illustrated Official Journal (Patents).*

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The Construction of Amateur Wireless Apparatus

This series of Articles, the first of which was published in our April number, is designed to give practical instruction in the manufacture of amateur installations and apparatus. In the following article the author deals with the important question of insulation. The Wireless Press, Ltd., has arranged with Marconi's Wireless Telegraph Co., Ltd., to supply complete apparatus to the designs here given, as soon as Amateur restrictions are released.

Article Two: INSULATION AND INSULATORS.

IN the last article we indicated broadly to the amateur the lines along which he should proceed when laying his plans for the erection of an aerial and the construction of an earth system. Before going into detailed arrangements of masts and aerials we propose to make a few remarks on the materials of construction employed in a station.

Insulating materials play a large part in both receiving and transmitting stations and their correct use is necessary for efficiency's sake. In a wireless station insulation is used for such widely different purposes as supporting an aerial and to form the dielectric of a condenser. In the first case the insulation is exposed to the action of weather, etc., whereas in the second it is completely protected. It will then be most convenient to classify insulators according to the purpose for which they are to be used.

It must be borne in mind that the insulation of the component parts of an oscillatory circuit must always be of the very highest order. Insulation which would be quite good enough for ordinary purposes, such as lighting circuits and bell installations, is not suitable for a transmitter or receiver for wireless telegraphy. Bad insulation of an oscillatory circuit is followed by reduced efficiency. In a receiver this results in weakening of signals; in a transmitter loss of power; and if spark waves are being emitted an unduly high damping. The three main questions of insulation are (1) The aerial, (2) Leading-in insulator, (3) Insulation of instruments. In the last class we include all the component parts of a transmitter and receiver.

Aerial Insulation. Undoubtedly the best material for all outside work is glazed porcelain. The desiderata of an aerial insulator are that it should have a good mechanical strength and that it should be unaffected by weather. Glazed porcelain fulfils both these conditions. Many types of insulators may be purchased which are constructed from insulating compounds moulded into various shapes. All of these suffer from the disadvantage that the surface of the material deteriorates under the action of weather. This weathering action is most important. Nearly all the conductivity of an insulator is due to faulty surface. The point is well illustrated in the behaviour of an ebonite insulator employed out of doors. Ebonite, under the influence of sunlight, undergoes a chemical change on its surface, resulting in the liberation

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of free sulphur. If a piece of ebonite be left exposed to sun and rain for a few days this effect can be easily observed; the surface will change to a greenish-yellow colour in place of the dead black of clean ebonite. This liberated sulphur, in contact with moisture and the oxygen in the air becomes oxidised to sulphurous and sulphuric acids, with the result that a conducting layer is formed and the insulation resistance of the insulator as a whole is lowered. This explains why an aerial suspended from ebonite insulators has a better insulation resistance after a shower of rain. The rain washes the surface of the ebonite and so removes some of the conducting acids which have formed. It will, therefore, be obvious that any articles made of ebonite should always be protected from direct sunlight and damp. For this reason ebonite has been abandoned for aerial insulation. Rubber suffers from the same disadvantage to a lesser degree, but possesses the important quality of flexibility and is not fragile like ebonite. Rubber "strop" insulators are consequently largely used for ship work, but it is necessary to keep the surface of the insulator covered with some inert insulating coating to protect it from the weather. A varnish having bitumen as a base is generally used.

The aerial insulator the amateur uses should therefore be either porcelain or rubber. Porcelain rod insulators made specially for aerial work can be purchased in various sizes. Such an insulator is shown in Fig. 1. It simply consists of a straight rod of porcelain with

Fig. 1.

a hole at each end. These insulators are everlasting and strong and are recommended. Care should be taken when hoisting the aerial, as, of course, they are brittle, but once the aerial is aloft and the insulators are consequently under only tensile stress they will be found strong and durable. For a portable station the rubber "strop" insulators shown in Fig. 2 should be used. These are specially moulded with a fibrous core

Fig. 2.

to give strength. Eyes are fitted at each end for attachment. These insulators are the only ones suitable for aerials which are constantly being erected and dismantled—any ordinary pattern would soon be broken in the process. Under these conditions it is not necessary to treat the surface of the insulator with any protecting varnish, as the aerial is never exposed for a long enough period for weathering to occur.

Excellent aerial insulators can also be made by stringing a series of porcelain "reel" insulators together. The reels are made in various sizes and patterns, that shown in Fig. 3

Fig. 3.

being a suitable type. The advantage of this method lies in the fact that the wire loops used for making the chain can be passed one round the groove of the reel and the next through the hole in the centre; so that a chain is produced which does not let down the aerial should a reel be broken. The wire loops being interlocked, the chain simply loses an insulator and becomes a little longer when such a breakage occurs. This type of insulation is strongly recommended whenever the aerial is erected above telegraph or telephone wires, as fouling will not occur should an insulator break. The number of

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reels to employ in each string depends on their size and design, five ordinary reels about 2½ inches in diameter will generally be found sufficient for a transmitting aerial and two for a receiving aerial. The numbers, of course, refer to the reels per chain insulator. It is obvious that in order to obtain the highest insulation, such as that given by the porcelain rods before-mentioned, a considerable number of reels per chain would have to be used; this makes the chains long and cumbersome and also reduces the height of the aerial. Readers are therefore advised only to employ this type of insulator when necessary for safety's sake.

Leading-in Insulator. The correct function of a leading-in insulator is to insulate the bare aerial lead from the wall through which it passes into the wireless room, and *not* to take the pull of the aerial down lead. The down lead should be strained to an insulator attached to some fixed point, such as a stake in the ground or a strong hook driven into the wall of the building, and the end of the aerial wire or wires should be led quite loosely through the leading-in insulator to the wireless room. The method is shown in Fig. 4. Of course, the "no joints" principle must be adhered to, the wire not being made off at the straining insulator but passed through the hole and whipped with soft copper wire. For all aerial work No. 20 soft copper will be found most suitable for whipping loops and eyes. By employing this method we are enabled to use a simple porcelain tube for leading-in. These tubes are made in various lengths up to about 36 inches long, a suitable diameter (outside) being about 1 inch or 1¼ inches. They may be either straight or may be curved over at the end. When the latter type is employed the curved end should be on the outside of the building and the tube should be fixed so that the mouth is downwards to prevent rain entering the building. In general, the straight tube will be found to meet all requirements. A cork in the outside end, with a central hole for the passage of the wire, will keep out the wet. The tube should project at least one foot clear of all roof drips on the outside and about 3 or 4 inches inside. No special holding arrangements are necessary. A hole into which the tube will fit tightly in a window frame or the wall of a wooden building is sufficient as there is no mechanical stress on the insulator. For leading through a brick building the tube may be cemented into a hole drilled through the wall.

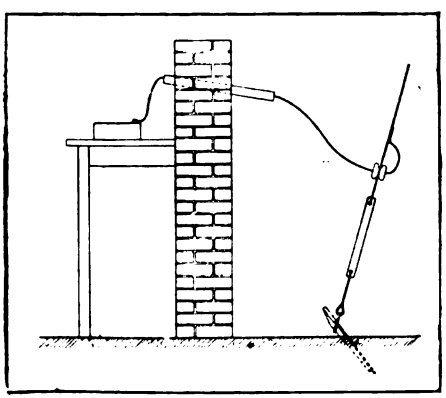

Fig. 4.

Insulating materials for the construction of apparatus. (*a*) *Formers for coils.*—Undoubtedly the best material to employ for tubes and formers for inductance coils is the best quality ebonite. It has the advantage of being an insulator of a high order and at the same time is good material to work and is everlasting. Ebonite formers are used for the coils of the best receivers produced commercially. Of course, the remarks we have just made with reference to the deterioration of this material do not apply when the ebonite is used for the construction of instruments. Nevertheless, even indoors, apparatus made of the material should not be left exposed to direct sunlight for long periods.

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There are many patent insulating materials sold for wireless purposes, nearly all these fall short of ebonite in some respect or other; consequently we advise the amateur who wishes to do the very best work to use it for all instrument work.

There is one point in this connection to which we would draw the reader's attention. It is found in practice that the operations of moulding ebonite articles, such as tubes, etc., results in the formation of a thin skin on the surface of the material which has a lower insulation resistance than the main body. This fact is of importance in several directions. For example, an inductance coil wound on a cylindrical former which has a more or less conducting surface, must have unnecessarily high losses in it when a high frequency current is flowing through the winding. Consequently, it is always necessary, before using commercial ebonite, to make sure that this conducting skin is not present. A simple test to enable the experimenter to settle this point is shown in Fig. 5. It simply consists in winding a few turns of copper wire on the article (a cylindrical former is shown in the figure) in two sections; the sections being each connected to the terminals of a spark coil. The distance between the nearest turns of the two windings is chosen somewhat greater than the spark length of the induction coil. If then, on working the coil a series of sparks are seen to jump over the surface of the ebonite we may be sure of the existence of the conductive skin. Of course, care must be taken, before the test is made, to see that the surface is perfectly dry and clean or a false result will be obtained. The amateur can easily modify the experiment himself in order to apply it to any moulded article of irregular shape. When the conductive surface is found to exist the skin of the material must be removed before it is used in the construction of any apparatus. This can be done by careful scraping or by rubbing down with first coarse and then fine glass-paper.

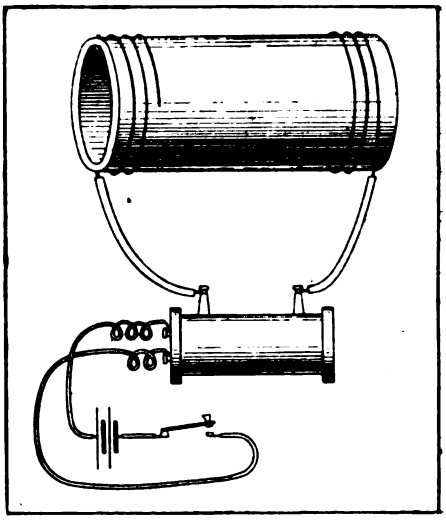

Fig. 5.

Many amateur wireless telegraphists will, no doubt, not wish to go to the expense of using ebonite for their instruments. Quite good results can be obtained from inductances wound on formers of paraffined cardboard.

The two main points to observe are: (*a*) the cardboard *must* be clean and dry before impregnation and (*b*) the wax must not be overheated when melting. The tubes, or sheets, of cardboard should be kept in a dry place and it is as well to warm them for a few hours before immersion. The paraffin wax should be of the very best quality and should not be melted over an open flame. Some form of "double boiler" is best for the purpose. A glue-pot serves well for small parts, but the amateur can easily make up a suitable bath for larger tubes and sheets. Thick cardboard, well impregnated, is quite suitable for mounting up receivers. Wood is not recommended, as individual specimens vary so much in insulation resistance.

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The Library Table

ELECTRICITY MADE PLAIN. By G. R. PEERS, A.M.I.E.E. London: John Heywood, Ltd. 2s. 6d. net. (2nd edition).

IN this little book the author sets out to explain in a manner suited to the non-scientific reader the various uses of electricity. Such an aim is necessarily very ambitious and covers almost the entire field of industry, yet we are of opinion that it has here been accomplished in a most creditable manner. Chapters 1, 2 and 3 are mainly given over to elementary explanations of electrical theory, whilst the remainder of the book introduces the reader to electricity at work in well-nigh every way of which one can think. Eight-and-a-half pages out of a total of a hundred and thirty-seven are devoted to wireless telegraphy and give a pretty good account of the subject—considering the public for which it is expressly intended. The book concludes with a glossary of electrical terms.

Having in view the author's attainments and the general excellence of this volume it is surprising to find here and there certain imperfections of writing.

On page 5 the author says, "In "dealing with the flow of a current of "electricity, it is necessary to understand "three terms, known as 'Ohms Law,' "which are: Volt, Ohm, Ampere . . ." And in the Glossary the ampere is defined as "One of the three funda- "mental electrical units (upon which all "electrical calculations are based)known "as 'Ohm's Law.'" The definition of Ohms Law itself (p. 137) is not at all happy.

On page 57 we read:—

"In the ordinary electric bell it will "be found that when the armature to "which the hammer is attached to the "magnet, and the bell is ringing, little "electric sparks are produced at the "point of contact, and each of these "sparks is sending out into space electric "waves, which with a sensitive apparatus "for indicating their presence can be "picked up and made use of. Such an "instrument is called a 'detector.'"

On p. 61 it is stated that the Eiffel Tower time signals are sent out at midday. Actually they are transmitted at 10 a.m., 10.44 a.m. to 10.49 a.m. and 11.44 p.m. to 11.49 p.m.

The third paragraph on p. 124 strikes us as inaccurate. Surely in an X-ray tube the electricity passes from kathode to anode, producing X-rays at the latter or at the anti-kathode, and not *vice versa* as stated.

The book is exceedingly well illustrated and well worth its price.

TEMPERATURE CONVERSION TABLE. Cambridge: The Cambridge Scientific Instrument Co., Ltd.

This table, printed in two colours on a stout glazed card 14½-in. by 12-in. takes the form of a spiral curve of four to five turns. On one side of the curve is shown the Fahrenheit scale, ranging from −460° to 3,630° by steps of 2° and on the other side is the Centigrade scale from −270° to 2,000° in steps of 2°. By this means conversion from one scale to another is reduced to a process of simple inspection. To provide for the conversion of temperature from the Réaumer degrees to both Centigrade and Fahrenheit degrees the necessary formulæ are prominently shown.

The card is a most useful study, laboratory or workshop companion and is issued by the publishers free of charge on receipt of sixpence to cover postage.

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Personal Notes

NEW APPOINTMENTS.

Mr. Henry William Allen, F.C.I.S., Director (formerly Secretary) and Mr. William Walter Bradfield, C.B.E., Director (formerly Manager) have been appointed Joint General Managers of Marconi's Wireless Telegraph Company, Ltd., and The Marconi International Marine Communication Co., Ltd. Mr. H. W. Corby, F.C.I.S. (formerly Assistant Secretary) has been appointed Secretary of the Companies.

RETIREMENT OF SIR J. J. THOMSON.

We learn that Sir J. J. Thomson has resigned his position as Professor of Experimental Physics at Cambridge. The Governing Body of the Cavendish Laboratory has appointed Sir Ernest Rutherford to succeed him.

Sir Ernest Rutherford is a New Zealander and was educated at Trinity College, Cambridge. In 1906 on the recommendation of Sir J. J. Thomson he was appointed Professor of Physics at McGill University, Canada. Twelve years later he returned to England to succeed Professor Schuster as Langworthy Professor of Physics at Manchester University.

Sir Ernest Rutherford carried out some important pioneer work to which was due the invention of the famous Marconi magnetic detector.

HONOURED BY THE KING.

From the London *Gazette* we learn that Major and Brevet Lieut.-Colonel (temporary Lieut.-Colonel) Bernard Calwoodley Gardiner, R.M.L.I., Fleet Wireless Officer, has been appointed by the King to be an Additional Member of the Military Division of the Third Class, or Companion of the Most Honourable Order of the Bath.

WIRELESS MAN GAINS AIR SERVICE MEDAL.

Sergt. Observer G. T. Newbold, R.A.F., has been awarded the Air Service Medal much to the gratification of his many friends. Sergt. Observer Newbold joined the R.N.A.S. as a wireless operator in June, 1916, being at first attached to the seaplane base in the Scilly Isles. From January, 1917, until January of this year he was engaged on flying duties, either searching for submarines, or as a member of escorting convoys to vessels in the English Channel or the Atlantic.

AIRCRAFT EXHIBITION FATALITY.

At Newcastle on the 26th of March the Coroner held an inquest on Lieut. Frederick Fenwick, test pilot, of Newcastle, and John Henry Underwood, air mechanic and wireless operator, of Dorset, who were killed at the Aircraft Exhibition owing to a mishap to their machine in mid air. After having heard the evidence the jury brought in a verdict of "accidental death." Evidence showed that the accident was caused by one of the wings of the aeroplane coming in contact when at a height of about 1,000 feet with the wire detention cables of a kite balloon.

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Company Notes

REPORT OF THE DIRECTORS OF THE MARCONI WIRELESS TELEGRAPH COMPANY OF AMERICA

To the Stockholders:

The Directors of the Marconi Wireless Telegraph Company of America respectfully submit herewith balance sheet, profit and loss account, and a summary of operations for the year ended December 31st, 1918, as certified to by Arthur Young & Company, Certified Public Accountants.

The operations for the fiscal year show, before allowing for Reserves, a net income of $908,358.14 as compared with $780,592.44 for the year 1917.

The net profits for the year, after utilizing $286,516.37 for Reserves, amounted to $711,841.77 as against $617,772.69 in 1917, or an increase of 15.23 per cent. This amount has been added to the Surplus, increasing that account, after payment of $499,975.00—1918 Dividend—to $1,631,415.78 at December 31st, 1918, and the Reserves set aside at that date for depreciation amount to $629,176.27 additional.

Your Directors are pleased to call attention to the dividend of 5 per cent. per annum which was paid August 1st, 1918, and to the declaration of another dividend of 5 per cent. per annum payable on July 1st, 1919, to stockholders of record June 1st, 1919.

Your company continued in 1918 its wholehearted efforts to co-operate with the Government in every way possible, in the conduct of the war.

Of approximately twelve hundred male employees on its roll, four hundred and fifty-six were numbered in the stars of its service flag, and seven were called upon to make the supreme sacrifice for their country.

Official recognition of your company's war service was expressed by Commander S. C. Hooper, of the Navy Department, on December 13th, in his testimony at the hearings before the House Committee on Merchant Marine and Fisheries on the bill providing for Government ownership of all radio stations. He said: (*Here follows an extract from Commander Hooper's speech in which he pays a tribute to the fine co-operation of the American radio manufacturers, inventors and amateurs with the Navy Department when the United States entered the war, mentioning specially Mr. E. J. Nally, the Vice-President and General Manager of the Marconi Company.*)

But, notwithstanding these fair words from its representative, the Navy Department never for a moment departed from its original desire to monopolize the radio business. Shortly after the signing of the armistice, it caused to be introduced in Congress, for the third successive time, a bill providing for Government ownership and operation of all wireless stations. This bill, known as H.R. 13,159, was considered by the Committee on the Merchant Marine and Fisheries, House of Representatives, at public hearings from December 12th to 19th. On January 16th, this Committee decided, by unanimous vote, to table the bill, and it is believed that no further attempt will be made to introduce similar legislation during the present session.

This danger, however, is by no means permanently ended, and every stockholder should remain on the alert and should promptly protest to his representative in Congress whenever any new attempt is made to pass measures calculated to destroy the business of your company.

The following pages taken from the "Hearings before the Committee on the Merchant Marine and Fisheries, House of Representatives" contain the arguments made by your officers at the hearings referred to, and will repay your careful reading.

For the Directors,

John W. Griggs, *President.*

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MARCONI WIRELESS TELEGRAPH COMPANY OF AMERICA.

Balance Sheet as at December 31, 1918.

ASSETS

CURRENT ASSETS:			
Cash—			
At Banks and on Hand	$140,489.20		
Collateral Call Loans	100,000.00		
		$ 240,489.20	
Accounts Receivable (less Reserve)		1,620,391.76	
Investments at Cost (Market Value December 31, $2,928,964.75)		2,989,316.97	
Inventories at Cost		1,008,106.42	
Total Current Assets and Investments			$5,858,304.35
STOCKS IN SUBSIDIARY COMPANIES			548,000.00
FIXED ASSETS:			
High Power Stations		$4,376,547.07	
Ship Stations		202,888.80	
Other Real Estate, Buildings and Machinery		232,784.55	
			4,812,220.42
DEFERRED CHARGES			20,178.92
PATENTS, PATENT RIGHTS AND GOODWILL			2,082,467.80
			$13,321,171.49

LIABILITIES AND CAPITAL

CURRENT LIABILITIES:			
Accounts Payable		$ 521,180.40	
Time and Demand Loans		190,500.00	
Total Current Liabilities			$ 711,680.40
DEFERRED LIABILITY TO AFFILIATED COMPANY			349,390.04
CAPITAL STOCK:			
Authorized and Issued—			
2,000,000 Shares of $5 each		$10,000,000.00	
Less: In Treasury		500.00	
			9,999,500.00
RESERVES FOR DEPRECIATION AND OBSOLESCENCE, ETC.:			
Of Ship Stations—			
As at January 1, 1918	$ 91,333.26		
Less: Amount utilized during 1918	57,000.00		
	$ 34,333.26		
Add: Amount set aside from 1918 Profits	20,288.88		
		$ 54,622.14	
Of High Power Stations—			
As at January 1, 1918	$ 87,470.64		
Add: Amount set aside from 1918 Profits	172,506.65		
		259,977.29	
Against Expiration of Patents—			
As at January 1, 1918	$200,000.00		
Add: Amount set aside from 1918 Profits	100,000.00		
		300,000.00	
Miscellaneous:			
As at January 1, 1918	$ 12,719.17		
Less: Amount utilized during 1918	1,651.52		
	$ 11,067.65		
Add: Amount set aside from 1918 Profits	3,509.19		
		14,576.84	
			629,176.27
SURPLUS:			
Balance per Certified Accounts, January 1, 1918		$1,419,549.01	
Add: Net Income for year ended December 31, 1918, after charging $286,516.37 Reserves		711,841.77	
		$2,131,390.78	
Less: Dividend paid in 1918		499,975.00	
			1,631,415.78
			$13,321,171.49

New York, February 19, 1919. We have examined the accounts and records of MARCONI WIRELESS TELEGRAPH COMPANY OF AMERICA, and have prepared therefrom the above Balance Sheet and accompanying Summary of Operation for the year 1918. These in our opinion correctly set forth the financial position of the Company at December 31, 1918, and its operations for the year ended that date.

ARTHUR YOUNG & CO.,
Certified Public Accountants.

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Questions and Answers

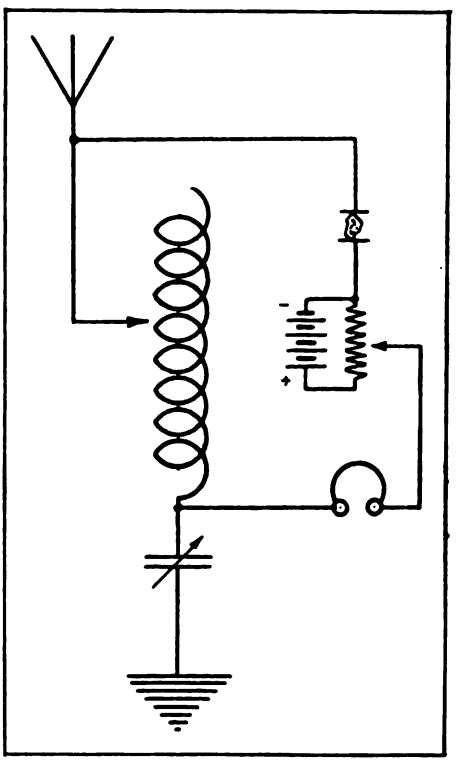
NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless telegraphy. Readers should comply with the following rules: (1) Questions should be numbered and written on one side of the paper only, and should not exceed four in number. (2) Queries should be clear and concise. (3) Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before. (4) The Editor cannot undertake to reply to queries by post. (5) All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom-de-plume." (6) Will readers please note that as amateurs they may not at present buy, construct or use apparatus for wireless telegraphy or telephony. (7) Readers desirous of knowing the conditions of service, etc., for wireless operators, will save time by writing direct to the various firms employing operators.*

CAPT. DE LA R. (Paris).—Asks several questions about valve circuits. As these questions are of general interest to our readers we have reproduced the diagrams in full.

Question A.—If all the circuits Nos. 1, 2, 3 and 4 work under exactly similar conditions, how would they compare for sensitiveness and strength of signals. The crystal used in No. 1 Circuit is a good carborundum crystal?

Answer.—Comparing circuits 1 and 2, the strength of signals received by circuit 2 will depend on whether they are strong signals or weak signals when received on circuit 1. If the signals are very weak then it is quite possible that the average increase of the current in the plate circuit, due to the positive half of the received oscillations is the same as the average decrease in the plate current due to the negative half of the received oscillations. In such a case therefore the average current flowing through the telephones will be zero. If, however, the signals are sufficiently strong a rectified current will flow in the plate circuit. Assuming that exactly the same amount of energy is received by each aerial of circuits 1 and 2, and is sufficient to give readable signals on circuit 1, stronger signals would be produced by circuit 2 owing to the fact that practically no energy is taken from the aerial circuit, as in the case of the crystal detector.

In circuit 3, an inductance coil and tuning condenser is added to the plate circuit, a rectifying crystal being connected across the condenser. There is now no necessity to rectify the incoming oscillations by means of the valve, and therefore the initial potential of the grid can be adjusted to such a value that for a given variation in the grid potential, due to the received oscillations, the greatest variation in the plate current is produced. By the use



No. 1.

of this circuit it is easy to receive signals that would be quite inaudible if received on a crystal circuit.

In circuit 4, we have the same circuit as in 3 but with the addition of an extra inductance coil in the plate circuit. By the introduction of this coil, the oscillations in the plate circuit are made to help the oscillations in the grid circuit, which in turn strengthen the oscillations in the plate circuit. When a valve circuit contains a reaction coil in the plate circuit, the

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From a Clerk.

Looking back over the time since I first enrolled for the Course, I marvel at the changed outlook and wide sphere which it opened out to me. The personal benefits are a great increase of self-confidence and a thousandfold better memory. If only the public *knew* your Course I am sure your offices would be literally besieged with prospective students.

From a Works Manager.

Your system has certainly been of great assistance to me in a variety of ways. Up to recently I was works manager for a big firm of yarn spinners, but have now attained the position of right-hand man to the owners, being removed from the executive to the administrative side of the business.

From a Bank Cashier.

I have much pleasure in testifying to the practical value of the Pelman System as a means of developing one's mental powers. My chief regret is that I did not take the Course years ago. I have found the training of great value in clearness of mental vision, quickness of decision, and greater self-confidence. The outlay is quite nominal compared with the great advantages attained.

"Mind and Memory" (in which the Pelman Course is fully described, with a Synopsis of the lessons) will be sent, gratis and post free, together with a full reprint of "Truth's" famous Report on the Pelman System and a form entitling readers of "The Wireless World" to the complete Course at a reduced fee, on application to the Pelman Institute, 145, Pelman House, Bloomsbury Street, London, W.C. 1.

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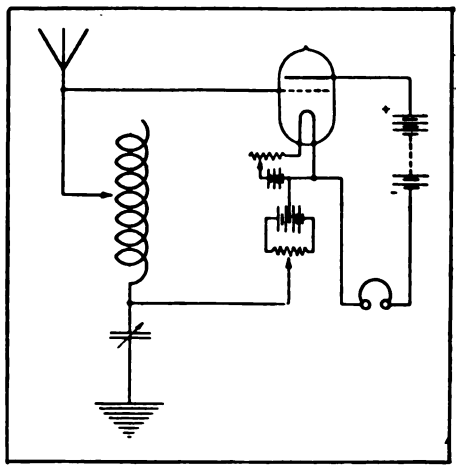
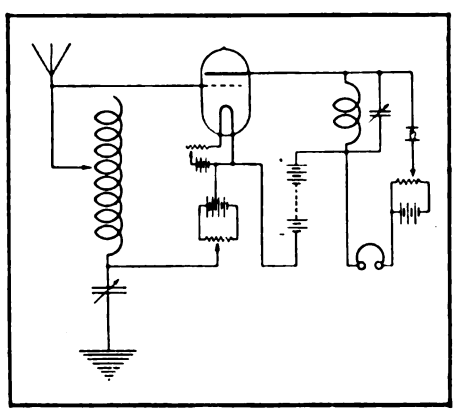


No. 2.

strength of the received oscillations can be enormously increased by making the proper adjustments, and very weak signals can be magnified so that they are readable a foot or so away from the telephones.

A valve circuit takes a smaller amount of energy from an aerial than a circuit containing a crystal detector. By means of a reaction coil in the plate circuit it can feed energy back into the aerial circuit, therefore the net result



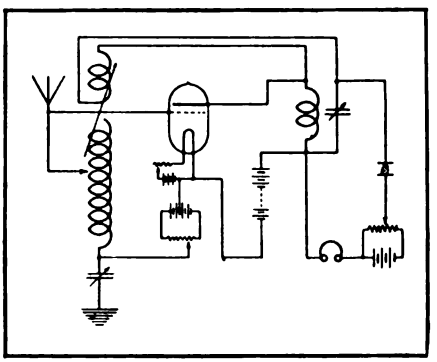
No. 3.

is that the losses in the aerial circuit are greatly reduced, and in fact the damping in the aerial can be made zero. Hence greater selectivity and sensitiveness is obtained with valves.

It is not possible to make any definite statement as to the relative magnifications of the circuits as so much depends on the efficiency of the valves and the conditions under which they are used.

Question B.—Looking at circuits 3 and 4 is it better when using a carborundum crystal and valve, to rectify first with the crystal and then amplify with the valve, or *vice versa*?

Answer.—The practice of the Marconi Co. is to amplify with the valve and then rectify with the crystal. This method presuppose that the signals to be rectified are of the average strength of signals on a non-magnifying receiver, and hence are suitable for ordinary crystals which are selected for signals of this strength.



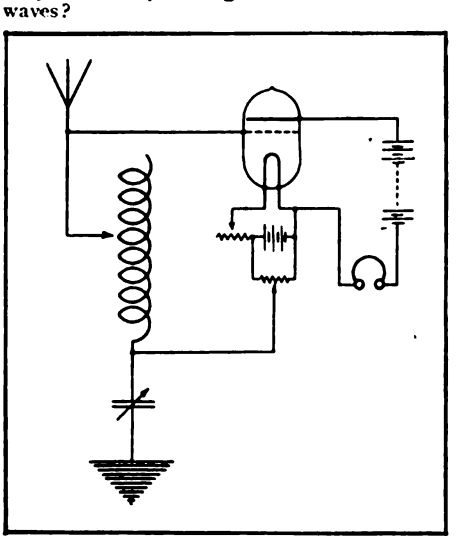
No. 4.

Question C.—Could not the grid battery be suppressed as in circuit 5 by combining the grid and filament batteries?

Answer.—Yes. This method is employed by the majority of valve receivers, thereby effecting economy of batteries.

* * *

Question D.—Can circuit 6 be used for the reception of spark signals and continuous waves?



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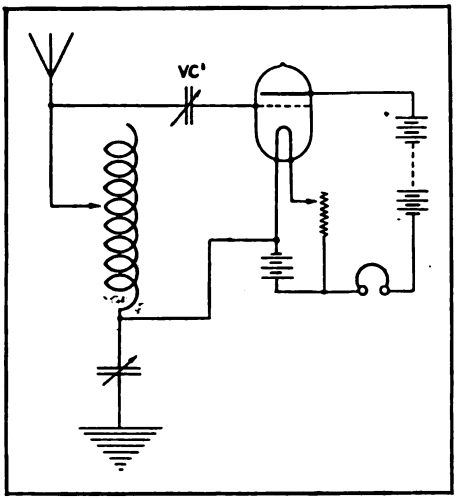
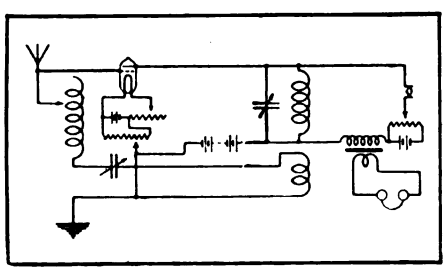


No. 6.

Answer.—This circuit is quite suitable for the reception of spark signals. The insertion of the condenser V.C. in the grid circuit is a common one in a number of American receivers. This condenser stores up the currents which are rectified by the valve. The charge and discharge of this condenser during the reception of incoming oscillations decreases and increases the Plate current at a low audible frequency, the group frequency in fact of the received waves.

This circuit is not suitable for the reception of continuous waves unless some external source of alternating current is made to super-



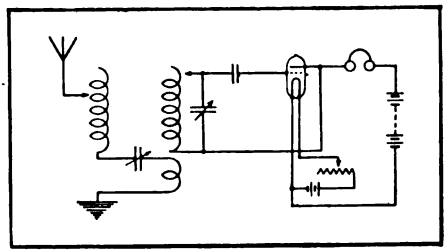
No. 7.

impose oscillations on the aerial circuit thus giving rise to what is known as "beat" reception.

Question F.—Would circuit 8 be suitable for the reception of continuous waves?

Answer.—This circuit is not very suitable for the reception of continuous waves. A somewhat similar circuit was used by Dr. de Forest some years ago and since improved. This circuit will only react, thus becoming suitable for the reception of continuous waves, when the aerial and secondary circuits are slightly out of tune. There is, therefore, no control over the frequency of the beats set up.

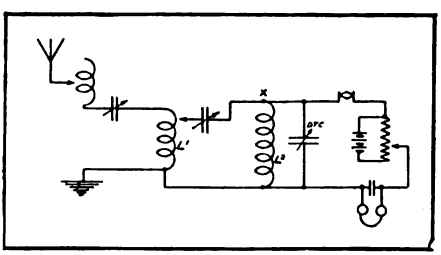
Question E.—Is not circuit 7 the most usual connections compared with circuits 3 and 4?



No. 8.

Answer.—Low resistance telephones in conjunction with a step-down transformer are generally used in the plate circuit because the operator is then less liable to shocks than when using high resistance telephones directly connected to a high tension battery.

Also less damage can be done to the insulation of the windings of L.R. telephones when breaking the high tension circuit than would be the case if H.R. telephones were used.



No. 9.

Question G.—Are the results obtained with this circuit good? Can L^1, L^2 be the same as in an ordinary two-circuit receivers? Can a valve, or valve and crystal together, be used in this circuit? What distance must separate L^1, L^2 so that they do not interfere one with the other?

Answer.—This circuit is a usual type of crystal circuit, and can be made to give good results, but it is better to have separate coupling coils.

L^1, L^2 can be of same construction as the inductance coils of an ordinary receiver.

If a valve were used the fact that the coupling is not adjustable through zero would probably prove detrimental to its use.

The distance between L^1, L^2 must be so great that the mutual inductance is very small, say so small as to give 1 or even 0.1 per cent. coupling. The best practice is to arrange these two coils at right angles one to the other.

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T.S.E. (Goole, Yorks.).—(1) There is no P.M.G. Certificate issued for Wireless Telephony at present. (2) The Postmaster-General is prepared to conduct an examination in the Marconi system of using continuous waves, if the applicant so desires. (3) As the aerial postal service does not exist at present we cannot answer your question. (4) In the preamble to a radio telegram the word "Radio" should be used as it has been officially accepted as meaning "wireless."

A.J.H.O. (Seven Kings, Ilford).—(1) The maximum age limit for operators joining the Marconi service is 25; the age limit for other technical positions depends upon what the position is, and as you do not specify any in particular we cannot answer you more fully. (2) As you possess a First Class P.M.G. Certificate you might apply to The Marconi International Marine Communication Co., Ltd., to be placed on their waiting list, but we do not think that you will obtain a shore position. For a post on shore you might try the firm you mention.

D.H. (Manningtree).—Subject to there being a vacancy we think that you would be eligible for an appointment such as you mention. You could get a definite ruling on the question by applying direct to the Company.

SYSTEMS (East Ardsley).—(1) We do not know of any book dealing exclusively with the Telefunken system, but can recommend you to read the section devoted to it which appears in *Wireless Telegraphy* by R. Stanley. (2) Similarly with the Poulsen system we know of no book dealing entirely with this. It is however discussed in most standard books on wireless telegraphy. (3) The Postmaster-General will examine an applicant in these systems if requested to do so, afterwards endorsing any certificate issued to the effect that the holder has passed in such systems.

G.L.C. (London, S.W.).—Sir O. Lodge has written a book entitled "The Aether of Space."

H.S. (Millom).—(1) Under a provision of D.O.R.A. you cannot at present obtain a licence to erect a wireless aerial. (2) When the said provision ceases to exist your application should be made to the Secretary, G.P.O., London. (3) You may not buy or make apparatus for wireless at present; follow the series of articles on the construction of such apparatus which commenced in our April issue, and study "The Elementary Principles of Wireless Telegraphy" by R. D. Bangay. (4) A handy man can make a very good amateur set if he understands the principles of the art of wireless telegraphy. Amateur apparatus will, we believe, be supplied by Marconi's Wireless Telegraph Company, as soon as law permits.

F.A. (Leeds).—(1) We think not. Why not apply direct to the various wireless and aviation companies. (2) You do not say to whose "Waiting List" you refer. If you mean that of The Marconi International Marine Communication Co., Ltd., the answer is "No."

J.B. (H.M.D., Sunset).—You do not say what position you want, or with what firm. If you mean the Marconi International Marine Communication Co., Ltd., apply direct to the Traffic Manager, addressing your letter to Marconi House, Strand.

"EX-OPERATOR" (Leicester).—(1) This matter is regulated by the Board of Trade to whom your enquiry should be addressed. (2) At present, the Board of Trade. It is not yet obtainable by private traders. (3) The bonus to which you refer has not yet been paid.

E.G.W. (Nottingham).—Has experienced trouble when using a wavemeter by the fact that when the wavemeter was brought near an oscillating circuit a constant sound was heard in the telephones. This effect might be caused either by some turns of the inductance becoming short-circuited, or some of the plates of the condenser being shorted. It is possible in either case that owing to a tight coupling between the wavemeter and the oscillation circuit, the wavemeter circuit was in a state of "forced" oscillation, thereby giving rise to a sound in the telephones but not capable of being tuned.

Were the safety spark gaps of the condenser cleaned, as a particle of dust will sometimes cause a leak between the condenser plates.

J.K.H. (Plymouth).—Asks (1) If a valve receiver when oscillating does not transfer energy to the aerial circuit and thus act as a transmitter? Yes, whenever a valve oscillates the set acts as a transmitter and any receiver in close proximity, tuned to the same wavelength, would be effected by the radiated oscillations. The set would of course be a very inefficient transmitter, but even this is sometimes quite sufficient to interfere with another receiver in the neighbourhood.

(2) The diagram on page 281 of E. Bucher's book showing the connections of a "beat" and "amplifier" valve receiver, are quite satisfactory and the receiver is capable of great selectivity and sensitiveness. The English Marconi Co. usually dispense with the grid condenser C.3 and the plate current tuning condenser C.4 as being unnecessary refinements. There is practically no difference between the valve illustrated and those manufactured by the English Marconi Co. In the American valves the grid takes the form of a fine winding whereas in those used in this country the grid is made of fine tungsten net.

L.J.B. (Blyth).—Full information on the subject appears in our issue for May, 1918. See also answer to A.E.W. (Catford) in this year's April number.

E.E.J. (Leytonstone).—Asks: (1) Why he gets better signals with long waves on a Type 16 (Marconi) receiver when the earth arrester is screwed up tight? (2) When one side of the telephones is connected to the A.T.I. handle why are signals increased when receiving on wavelengths above about 2,000 metres?

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AT ONCE

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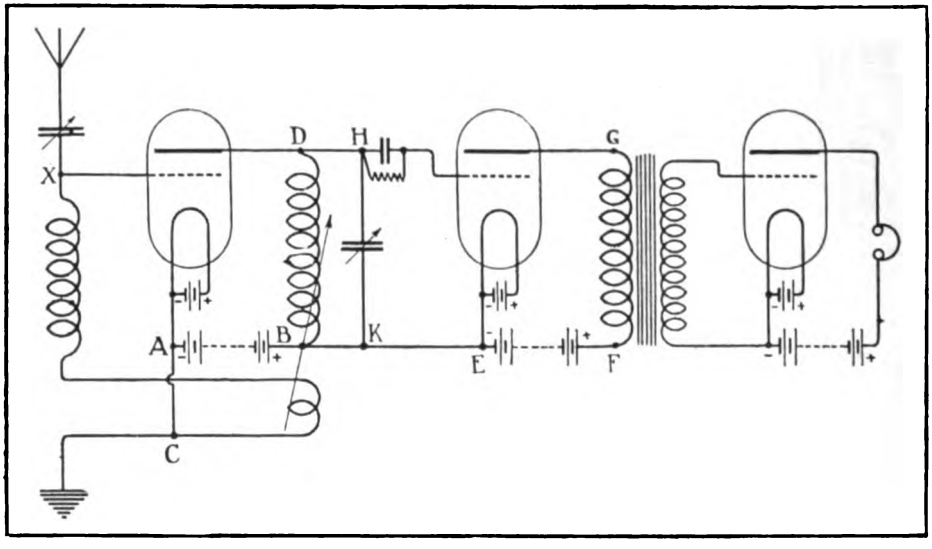
Answer.—(1) If "E.E.J." means that when his earth arrester is screwed up tight there is still an insulating space between the two plates then we are inclined to think that the earth arrester is acting as a small capacity across the A.T.I. of the receiver, the better strength signals then being due to better A.T.I. tuning. Possibly a few turns of the A.T.I. are short-circuited, and the earth arrester acting as a capacity, make up for the loss of turns. If screwing up the earth arrester causes the two plates to touch one another then the A.T.I. becomes short-circuited, and we are at a loss to account for the increase in the strength of signals.

Answer.—(2) By connecting one side of the telephones to the A.T.I. the receiver works on a plain aerial, with no electro-magnetic coupling between the primary and secondary circuits. The coupling is greater when using a plain aerial, but the extra coupling is



obtained at the expense of selectiveness, it being much more difficult to "tune out" any particular station.

CAPT. DE LA B. (Martenet).—Wishes to know if in a three-valve receiver it is not possible to combine the high and low tension batteries into two batteries?

Yes, it is usual to let one high tension battery suffice for all the plate circuits and one low tension for all the filaments. Connect the filaments in parallel, and then connect the negative side of the high tension battery to the negative side of the low tension battery. This connects points *AE* and the negative limb of the third filament to the negative side of the High Tension battery. Break the connection between the plate circuit coil of the first valve and the negative side of the second valve filament, *i.e.*, *KE*, and insert a condenser of capacity not less than .01 mfd. The points *B* and *F* and one side of the telephones can now be connected to the positive side of the High Tension battery. The reason for inserting the .01 mfd. condenser is because the connection *KE* would short circuit the High Tension battery. The rest of the connections remain the same.

R.K.L. (Birmingham).—Wishes to know whether an ordinary gramophone sound box can be used in conjunction with a gramophone record for the reception of wireless signals.

It would be practically impossible to use a gramophone to record wireless signals under the above conditions. To use successfully this method a special sound box would be required fitted with very sensitive telephones, such as Brown's telephones, and the received signals have to be strong enough to cause the diaphragm of the gramophone to vibrate sufficiently in order to mark the record. This usually means that the signals have to be magnified several times in order to render them loud enough.

The only method of cleaning a record of old tunes or words is by taking a thin cut along the face of the record. Gramophone makers supply a special "shaving" machine for this purpose.

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THE
WIRELESS WORLD

No. 75
Vol. VII

JUNE
1919

Wireless in the Canary Islands

By A. Anselmi.

EARLY in 1917 it befell my lot to visit another beautiful country and so add to many and varied experiences on the Iberian Peninsula. I was to proceed to Teneriffe, one of the seven Canary Islands, to fit a Spanish gunboat with a 3-kw. Marconi installation. At the time of receiving my marching orders travel in this part of the world was very uncertain owing to the ruthless warfare waged by the pirate Huns against all neutral shipping. So, after many enquiries, resulting in as many vague replies, as to the actual sailings of vessels for the Canary Islands, I started on my journey from Madrid about the middle of April. The first part of it took me through some of the most picturesque and interesting parts of southern Spain. We traversed the extensive plains of Andalucia, where large herds of bulls can be seen grazing. The old towns of Cordoba and Seville, jewels of the ancient Mauresque Spain, we passed on our way to Cadiz. It had been my hope to reach this port in time to take passage on a large transatlantic boat which was due to sail for South America, calling on her way at Teneriffe. Although I arrived in Cadiz some six hours before the actual sailing of the ship, the shipping agents informed me that no more passages could be booked, owing to the consular formalities made necessary by the submarine menace. This shattered my prospects of a comfortable trip and forced me to voyage on a small 1,000-ton mail boat two days later This was by no means a happy experience for me, as rough seas were running at the time, and, to crown it all, it took nearly four days to effect the crossing, thus adding much to the general discomfort.

Never did anyone have a more uneventful trip! During the whole voyage we did not sight a single ship, although everyone on board expected at any moment the appearance of a periscope. Some nervousness was displayed by the lady passengers. No cheering wireless spark broke the monotony on board, owing to restrictions on wireless transmission. I will now draw the curtain over those dreary four days of sea voy-

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Photo: Exclusive News Agency.

A view of Teneriffe and its famous Peak.

aging and relate the wonderful scenes which greeted my eye on the morning of the 17th April as the boat made its entry into Teneriffe harbour.

The island of Teneriffe boasts as being one of the world's most charming spots and well deserves the name of Fortuna Insula, given her by the ancients. Her capital, Santa Cruz (de Teneriffe) possesses a very secure harbour and lies at the north-east side of the island. It has a population of approximately 40,000 inhabitants, mostly Spanish. The oriental aspect of the town, with its low flat-roofed and white-washed houses, is very pleasing to the eye. This wonderful picture cheers the heart of a traveller coming from the foggy north. In spite of the largest hotels being closed on account of the war, many smaller ones afford very fair accommodation for a not too fastidious traveller. The abundance of food surprised me. My friends on the mainland had informed me prior to my departure of the desperate food conditions in the Canary Islands, and consequently it was an agreeable surprise to find this fear baseless. This abundance was evidently not enjoyed by the poorer classes, for the prosperities of the island in general were greatly reduced by the absence of pre-war shipping on which the labouring classes depended for a living. In the far-off days of peace as many as twelve liners a day could visit Teneriffe, each boat helping to swell the coffers of the petty tradesmen.

An important factor in the town's busy commercial life is its large wireless station, of which I will speak later.

During my stay in the island I had many opportunities for visiting this station, and later I was called on to run it for some time during the unfortunate illness of its chief.

There in the harbour I found the

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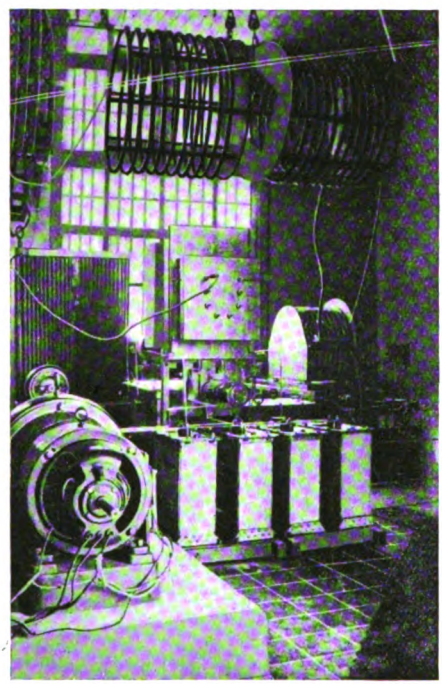
gunboat "Toya," the last of her class not fitted with a wireless installation. This boat, of some 800 tons displacement, had been built in Cartagena's extensive Naval Yards, and had since been entrusted with the difficult task of patrolling the seas round a certain group of the Canary Islands. The low draught which the boat possesses makes voyages on her very uncomfortable, a fact with which I soon became acquainted. The wireless gear had preceded me, and, after some pains in finding suitable labour for the work I proceeded with the erection of the wireless cabin. The extreme slowness with which work proceeds there is at times very exasperating. This by no means surprised me. Anyone who works in southern climes knows of the easy-going nature of the workmen. Their frequent rolling of cigarettes makes one wonder how any work is ever accomplished.



Transmitting Gear, Teneriffe Station.

Religious and secular feasts provide workmen with many holidays and interferes still more with work. These holidays seem especially abundant in this district, and taxed our patience to the utmost limit. On one of these days I witnessed a sight unique in its magnificence. It was "Corpus Christi" day, and my friends urged me to take the opportunity to witness the wonderful carpets of flowers lining the principal streets of the town of La Laguna, a few miles from Teneriffe. It was a very hot day, and, while the tramcar wended its way wearily up the hill in the direction of La Laguna, I wondered if all my trouble was worth the while.

On arriving at the top of the hill the sight well rewarded me for my exertions. There in front of me, streets after streets were covered with carpets of wonderfully clever designs, and all of them made with millions of petals from many different natural flowers. Shows of this nature sort well with the easy-going, artistic temperament of the people. Work now proceeded normally on board the gunboat, and the wireless installation was nearing completion. The aerial, composed of six wire "sausages" of the T pattern, was erected, and things looked very hopeful when one fine day the island was visited by a most unwelcome guest! Influenza made its appearance and very soon the hospital at Santa Cruz overflowed with patients. On board the gunboat the first attacked were the stokers and machinists, and very soon of a crew of 90 only 10 officers and men remained on board.

Fortunately the wonderful climate prevailing there helped greatly to reduce

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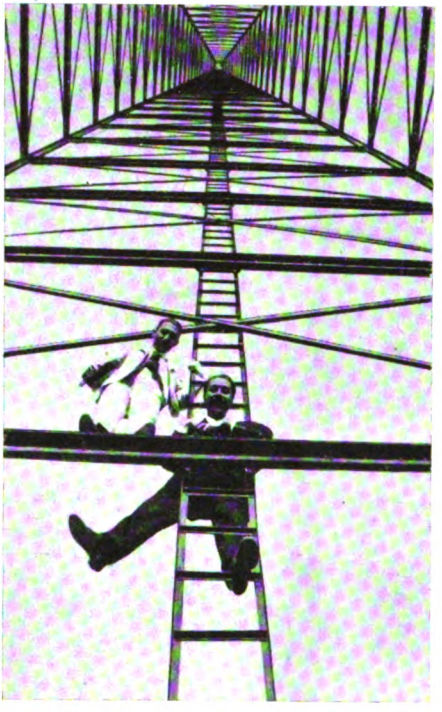
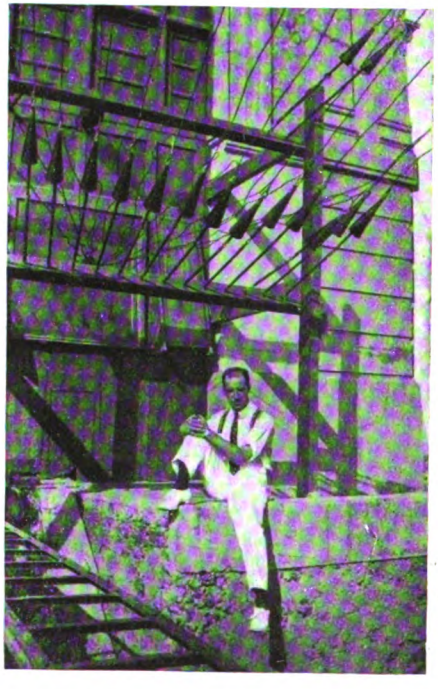


Inside view of lattice mast.

the effects of the epidemic, so that soon the abandoned ship had once more its entire crew on board.

The work was at length finished, and, after some preliminary tests, I awaited the date of the official trials. These were to take place at a minimum distance of 40 kms. from a land station. Far from enjoying the prospects of the voyage to the point "P" (as we called the spot from which trials were to be carried out) I rather dreaded it, and would like to impress on my readers the fact that wireless trials on any kind of warship are not exactly pleasure trips, there being much worry, to say nothing of probable sea sickness. The station on board the gunboat, "Toya," of the usual Marconi 3-kw. type, looked very neat indeed in the roomy white-painted cabin. The transmitting part consisted of a 3-kw. converter, having a shaft extension and Marconi disc discharger, giving a nice musical note of 600-spark frequency. This machine, together with the transformer, primary reactance and choke coil, was located under the large transmitting table inside the silence cabin. On top were the condensers of the hot-plate type, the wave change switch, the oscillation transformer, while on the left-hand corner the emergency coil with its spark gap stood ready to carry on should the ship's dynamo fail for any reason to supply the main set with current. The receiving table, at right angles to the transmitting table, was fitted with two crystal receivers, one for short and the other for long wave reception. Switchboards, starting resistance, aerial tuning box, aerial ammeter, etc., occupied the



The author beneath the aerial leads.

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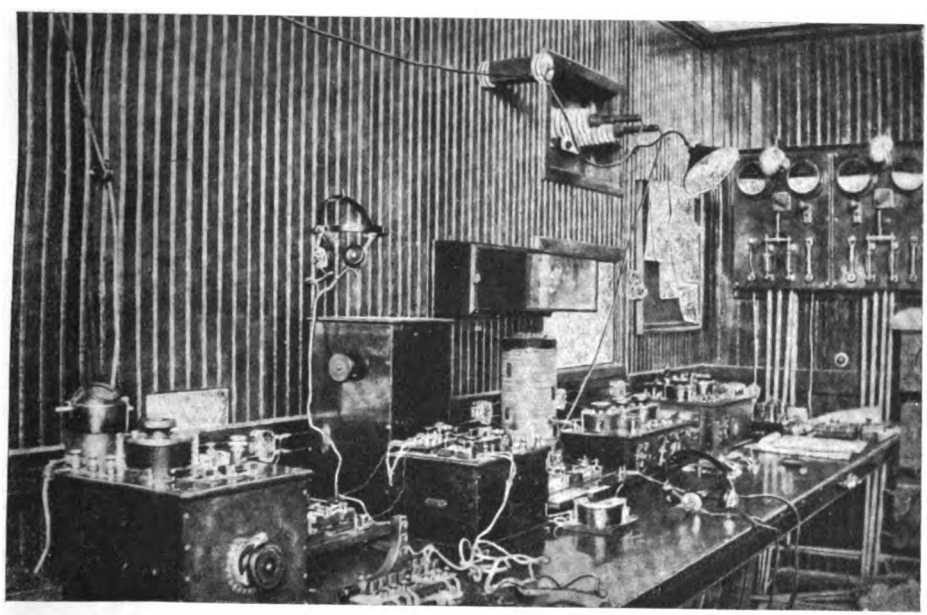
four walls of the cabin. Many cares assail the wireless engineer on the eve of the official trials and not until these are satisfactorily ended, thus proving once more the efficiency of this system of communication, is the mind really at rest.

The Teneriffe wireless station, conspicuous by its four lattice towers, stands some little distance from the centre of the town. The towers placed some 300 feet distant from each other support an inverted L aerial by means of a triatic. The aerial is about 450 feet in length and is composed of 12 wires in parallel. Two other smaller antennæ run parallel to it, and are used for reception and transmission with the 3-kw. ship set. The main aerial of 12 wires is brought to a lead-in insulator fixed in the middle of a glass pane on the south side of the transmitting room. On the opposite side of the receiving table are the switchboards controlling the motor generator and disc of blower motors in the transmitting room. The power for driving the machinery is supplied from a 110 accumulator battery of some 700 ampere hours' capacity. This battery is charged by means of a dynamo directly coupled to a Gardner oil engine of 60-h.p.

The building possesses a very large transmitting room containing the Marconi 20-kw. and 3-kw. sets. The former set has remainders of a disused French wireless station, namely, a bank of 160 Moscicki tubes, placed in a pit some five feet deep. The duplicate synchronous disc discharger with its respective blower transformer, low frequency inductance, transmitting jigger, motor generator, and aerial tuning inductance suspended on the roof, completes this set.

On the left-hand side of this room stands a 3-kw. Marconi set used for communicating with ships and the surrounding islands.



The receiving room at the Teneriffe Station.

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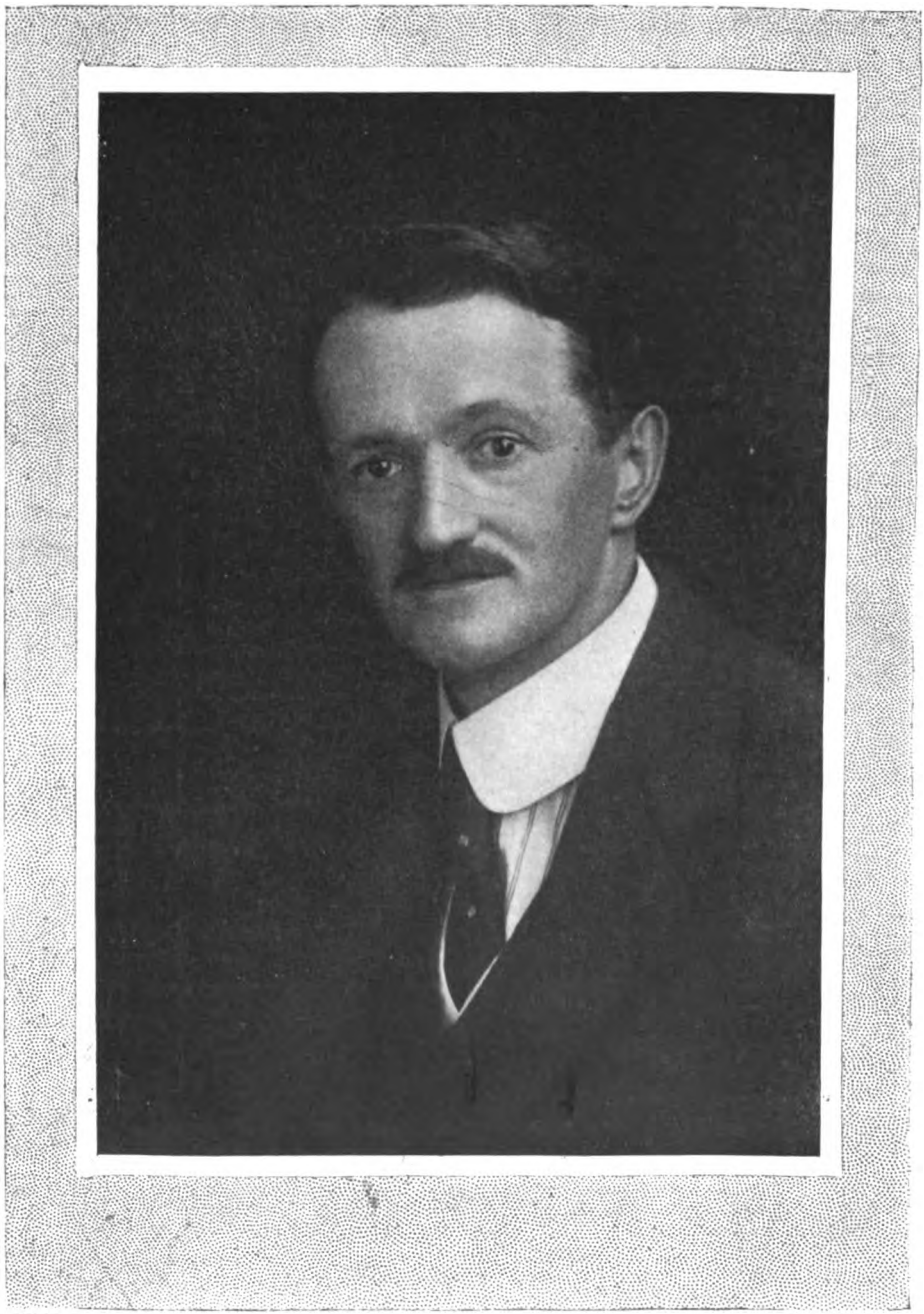

Photo: Elliott & Fry.

MR. HENRY W. ALLEN

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Personalities in the Wireless World

MR. HENRY W. ALLEN, F.C.I.S., was born in London on July 31st, 1870. Educated at Wilton and at Pitman's School, London, he spent four years at Tunbridge Wells, and then, in 1891, commenced commercial life in the Metropolis. In 1892 he entered the service of Mr. H. Jameson Davis, a cousin of Senatore (then Mr.) Marconi, and four years later made the acquaintance of the illustrious inventor himself, who came to England in 1896.

The following year saw Mr. Allen assisting in the formation of the Wireless Telegraph and Signal Co., Ltd. (the forerunner of what is now the world-wide Marconi organisation), and on its incorporation in 1897 he became its Secretary. The April of 1900 marks his appointment as Secretary of the newly-formed Marconi International Marine Communication Co., Ltd., and as Assistant Manager of Marconi's Wireless Telegraph Co., Ltd., of which latter firm he became Deputy Manager in 1910. In 1911, and again in 1913, Mr. Allen visited the United States and Canada in connection with the affairs of these two Marconi Companies, and after a lapse of four years was in 1917 elected to a seat on the Board of each. He was appointed Joint General Manager with Mr. W. W. Bradfield, C.B.E., of the same Companies in April, 1919, a position which he holds now.

Throughout his long connection with the Companies to which we have just referred Mr. Allen has consistently held in mind the welfare of the staffs which he was called upon to control, and as one example of this we may mention that he was personally responsible for the introduction and organisation of the beneficent Pension Scheme which is enjoyed by the employees of the Marconi Companies.

In addition to the positions which Mr. Allen occupies in respect to the management of the great wireless telegraph enterprises of this country, he is a director of the Relay Automatic Telephone Co., Ltd., and of the Sterling Telephone and Electric Co., Ltd., and other firms. He was elected a Fellow of the Chartered Institute of Secretaries in 1902, and a Member of the Council of that body in 1916.

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The Weagant "X-Stopper."

ONE of the greatest troubles in the operation of wireless receivers of all types is the disturbance arising from the reception of atmospheric strays or X's. It may be said that, in general, the disturbing effects of X's have come more prominently into notice with the development of more sensitive receivers. To take two extremes of the problem the interference due to these atmospheric impulses even in the old coherer days—bad though it then was—was almost as nothing compared with the terrific disturbances often experienced in modern long-distance receiving stations.

It is a fairly well-established fact that in most localities the intensity and number of strays received increases with the wavelength to which the receiving instruments are tuned. This applies to the majority of strays experienced in normal working, but under certain circumstances—particularly when local thunderstorms are prevalent, as in tropical regions—the reverse conditions are sometimes experienced.

The modern tendency to use longer wavelengths with the growth of the power of the stations, and of their effective range, has therefore brought in its train increased troubles from this cause—troubles which the introduction of amplifiers has not lessened, but rather aggravated.

A great many ideas and inventions have already been put forward for eliminating or, at least, reducing the effects of this troublesome hindrance to communication. A certain measure of success has been obtained in many cases, but the results are, nevertheless, very far from perfect. The essential idea of most of them is that of some form of balancing arrangement that will not seriously interfere with the strength of the received signal, but will yet enable the atmospheric to be more or less cut out.

In general it was found that, at the best, these schemes only served to reduce the atmospheric strength and not actually to cut it out—that is to say, they served somewhat to increase the ratio of strength of signal to strength of atmospheric.

The reasons for this may be seen in the following: Consider the circuit shown in Fig. 1 which represents the diagrammatic arrangement of one of the best methods, known as the Balanced Aerial method.

The arrangement consists essentially of two separate aerial systems A_1 A_2, joined up to a common earth E, though the usual tuning coils L_1 L_3 and L_2 L_4 of two complete receiving sets. A common detector circuit L_5 L_6 C_1 is coupled to both aerial circuits as indicated. It is provided with a single detector D and telephones T in the usual manner.

To employ this circuit to reduce interference from X's, one of the aerial circuits, say A_1 L_1 L_3 E, is tuned accurately to the desired signal, which can then be heard in the phones T. The other aerial A_2 is then tuned up in a similar manner, when if coils L_5L_6 in the detector circuit are connected up in

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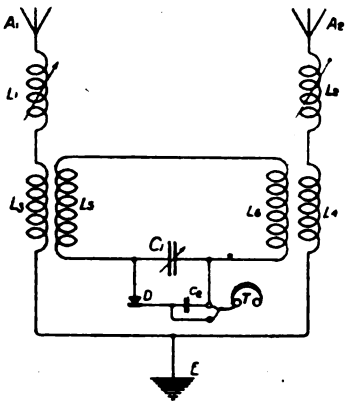

Fig. 1.

opposition, no signal should be received. By detuning one of the aerial circuits from its normal adjustment, the signal currents received in the two aerials are no longer equal and therefore no longer neutralise one another. Since, however, the X impulses have no particular wavelength, they still affect both aerials approximately equally, with the result that the effects of the atmospheric impulses should still cancel out in the detector circuit. A certain measure of success is obtainable but perfect results cannot be secured. The majority of X's consist merely of an electrical impulse which has the effect of an electrical blow upon the receiving aerial and so sets up oscillations therein. The process is analogous to the shock excitation of a transmitting aerial by means of a quenched spark gap. The oscillations set up in the aerial circuit by an X impulse are therefore *free* oscillations possessing the frequency of the *aerial circuit itself* and not of the outside source. The damping of the oscillations, too, is dependent solely upon the natural decrement of the aerial and its attached circuits. Hence the oscillations induced in each of the aerial circuits (Fig. 1) by the X impulse will be of different frequency and decrement since the two circuits are purposely detuned. It is, therefore, obviously not possible perfectly to balance out two opposing E.M.F.'s of different frequency.

It is important to note that two opposing E.M.F.'s. can neutralise each other *only when they have the same frequency, the same wave form, and opposite phase.*

In the case of damped oscillations, in addition to the above requirements, the damping of the two E.M.F.'s must also be identical. Similar remarks apply to the method in which two tuned circuits are branched off the same receiving aerial instead of employing two separate aerial systems.

Somewhat better results are possible by means of an audio-frequency balance (Fig. 2), in place of the foregoing arrangements using radio-frequency balance, but perfectly reliable results are not obtainable for reasons described above.

The Marconi Balanced Crystal and Balanced Valve Receivers perform a species of audio-frequency balancing. By their use the intensity of the disturbances arising from atmospherics may be reduced but not entirely eliminated.

From time to time attempts have been made to get rid of atmospheric inter-

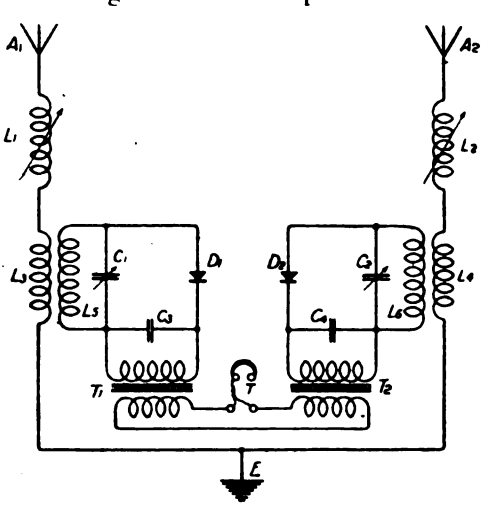

Fig. 2.

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ference by means of various forms of directive receiving apparatus, such as the Marconi-Bellini-Tosi Radiogoniometer used in conjunction with double triangular loop aerials. Tuned interference from near-by transmitting stations can be considerably reduced by this means.

It has been found that the different types of X's differ considerably in their electrical characteristics. Dr. Eccles has classified X's into three main types:—"Grinders," "Clicks" and "Hiss" or Sizzle."

The most prevalent type varies with the locality of the receiving station. In tropical regions a great deal of the disturbance is due to local lightning discharges. In temperate regions, apart from infrequent local storms, the most common forms are Grinders and Clicks.

Hissing noises are due to actual static discharges from the aerial to earth caused by electrostatic induction from charged clouds or winds. In transatlantic communication it is found that "grinders" are the most troublesome type of disturbance.

Disturbance arising from definitely positioned local thunderstorms can evidently be located and cut out by means of direction-finding receiving apparatus.

Extensive experiments were carried out by Mr. Weagant, the Chief Engineer of the Marconi Wireless Telegraph Company of America, at the stations and works of the American Marconi Company with the Bellini-Tosi and other forms of directive receiving apparatus in order to determine the location (if any) of the most prevalent forms of atmospheric ("grinders"), and it was found that there was *no appreciable difference* between the strengths of atmospherics received from different directions; in other words, the X's appeared to converge upon the receiving aerials from all directions in space simultaneously.

The same general results were confirmed by the use of closed loop unearthed aerials or "frame" aerials as they are now often called. A diagrammatic outline of the "frame-aerial" circuit is indicated in Fig. 3.

The "aerial" itself comprises the loop of wire L. This may consist of one or more turns as convenient for the wavelength being used. The lower ends

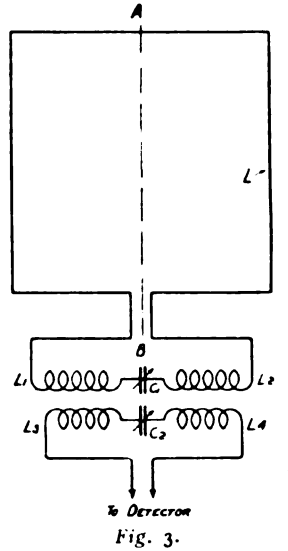

Fig. 3.

of the loop are joined to inductances L_1 L_2, and tuning condenser C_1, to tune the whole circuit to the frequency of the incoming signal waves. The detector circuit comprises the inductances L_3 L_4 coupled to L_1 L_2 and the tuning condenser C_2.

Such a loop aerial receives the maximum intensity of signal from waves arriving in the plane of the loop itself and minimum or zero signal from waves arriving from a direction perpendicular to this plane. Hence, by rotating the loop about an axis AB, the direction of maximum reception can be moved round to various points of the compass and the direction of an incoming wave thus determined. With this arrangement, too, Mr. Weagant found that the X's

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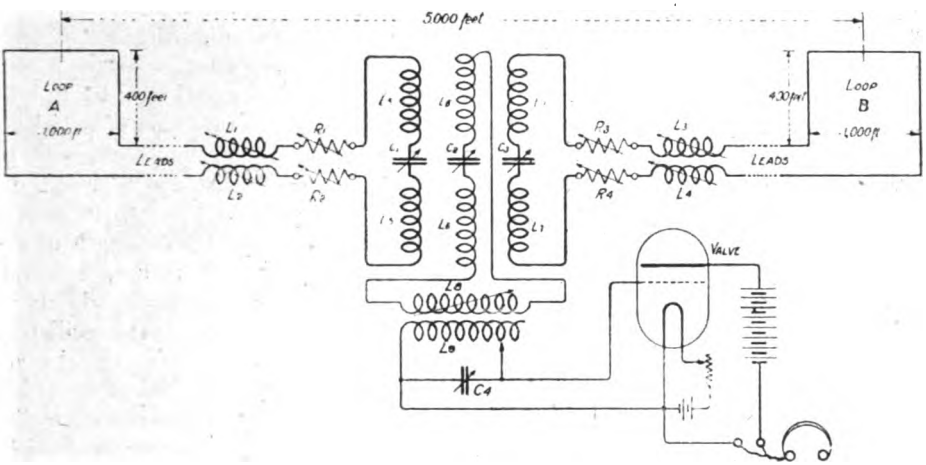

Fig. 4.

were received with equal strength independently of the direction of orientation of the plane of the loop.

As a result of these and similar experiments it occurred to Mr. Weagant that these static disturbances might be propagated *vertically*, instead of horizontally as is the case with ordinary wireless signal waves. Hence, if this is so, the direction of propagation of the X waves would be at right angles to the direction of the advancing wireless wave.

If this hypothesis could be definitely proved, then advantage might be taken of this difference in direction to separate the atmospheric from the signal currents flowing in the aerial circuit. This is the fundamental working hypothesis upon which the Weagant system is based.

Various experiments were subsequently devised in order to test the accuracy of this assumption, with uniformly confirmatory results.

Hence, if we accept this hypothesis of two mutually perpendicular directions of wave propagation, it merely remains to devise a scheme of aerial arrangement that will enable advantage to be taken of such a difference, so that the atmospheric waves may be cancelled or balanced out, without seriously impairing the reception of the desired signal waves.

One of the schemes devised by Mr. Weagant for this purpose takes advantage of the above-mentioned directive properties of loop aerials to enable the direction of maximum intensity of signal reception to be made to coincide with the line joining the receiving station with the transmitting station from which it is desired to receive.

The principle of the method is indicated in Fig. 4.

Two loop aerials A and B are employed, connected by long parallel leads to the apparatus in the receiving station which is placed approximately midway between the two loops. The variable inductances L_1 L_2 and L_3 L_4 serve to tune each loop circuit to the frequency of the incoming waves in conjunction with the variable condensers C_1 C_3. Coils L_5 and L_7 form the fixed coils of a radiogoniometer similar to the usual type used in the Marconi Direction-Finding Sets.

The movable coil L_6 of the radiogoniometer is tuned by the condenser

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C_2 and the external inductance L_3, which is coupled to the usual type of valve receiving circuit as shown.

It should be noted that on account of the directional effect of loop aerials the plane of the two loops should be, as nearly as possible, in line with the direction of the transmitting station.

It then follows that as far as the horizontally propagated incoming signal wave is concerned, there is a phase difference between the currents induced in the two loop circuits, whereas both loops are symmetrically placed as regards a vertically propagated X wave. It is therefore possible to cancel out the two currents induced by the X disturbance and yet leave the signal wave current strength unimpaired.

The two loops must be spaced a considerable distance apart, in order to take full advantage of this type of aerial arrangement. The optimum effect is obtained when the distance between the centres of the loops is as nearly as possible one-half of the wavelength of the incoming signal. It is not, however, essential that the loop spacing should be exactly of this amount, as the oscillatory currents in the two loop circuits are combined vectorially by the radio-goniometer. Hence a somewhat smaller spacing will give rise merely to a slight reduction in the received signal strength.

(To be continued.)

MAGNETIC STORMS.

IN the course of an interesting lecture on the above-mentioned subject, delivered before the Institution of Electrical Engineers on May 1st, Dr. C. Chree, F.R.S., while not specifically discussing wireless matters, brought to light a number of important facts that should be of great interest to wireless circles. The bulk of the lecture was devoted to a consideration of a number of very instructive records taken from magnetographs in various parts of the world, including some obtained during Antarctic expeditions. A notable feature of a great many of the records of magnetic storms is the very sudden changes in the value of the magnetic force that occur in particular at the commencement of a disturbance, and sometimes at intervals throughout its duration. It is conceivable that such sudden changes of the magnetic field may also give rise to disturbances in the telephones of wireless receivers. It has been proved by the examination of many records that a certain class of disturbance—particularly those with a sudden commencement—occur simultaneously over almost the entire globe. By averaging the records it has been shown that the bulk of magnetic storms occur in the evening and early hours of the night. Maximum increase of amplitude of the disturbance with increasing latitude is in a north-westerly direction in the British Isles, identical with the direction of maximum gradient of the frequency of auroral displays, proving at least some inter-dependence and hence possibly some connection between magnetic disturbances and wireless X's.

Some observations made at Bordeaux, of a magnetic storm on August 21st to 23rd, 1918, are of interest as showing that simultaneously with the variations of magnetic force exactly similar and synchronous variations of the electrical charge of the lower air also occur.

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Stray Waves.

COMMUNICATION WITH CELESTIAL BODIES.

AS a result of a few observations let fall by Senatore Marconi during an interview which he granted to Mr. Harold Begbie last January, widespread interest has been aroused in the subject of extra-terrestrial communication. We have seen the columns of our contemporaries extend their hospitality to a considerable number of attempts to develop ideas in this direction and have had the pleasure of hearing for the *n*th time about those delightful perennials, the Martians and their "canals." It appears to us that the question of whether we can or cannot communicate with other parts of the universe depends chiefly upon four things: (1.) Whether there is life there. (2.) Whether it is intelligent life. (3.) Whether the intelligence (if any) is sufficiently advanced. (4.) Whether the intelligent organisms (if any) *can communicate back to us.*

Firstly, nobody knows whether there are life-forms on Mars or any other planet. Speculation on the subject is rife, yet this "butters no parsnips." Prof. P. Lowell thought Mars is inhabited, but Prof. Russell Wallace wrote a book in order to prove that it is not only uninhabited but *uninhabitable.* As to the "canals" they may be the work of Nature, they may be the work of intelligent beings or they may be optical illusions. Here is a wide range of choice over which our readers can exercise their minds. Secondly, assuming the existence of highly intelligent organisms, one has to consider in what direction their bodies and intelligence have developed. Our distant fellow-creatures may be very clever *fish* possessing a perfect command of telepathic communication, but no implements, or they may live entirely underground and think in terms of four dimensions, and so on. Thirdly, unless they can reply in such a manner and by such means as will render it possible for us to receive the message and to be quite sure of the "office of origin" the whole attempt will be hopeless.

It has been suggested that communication might be effected by the means of light, a proposition which sounds reasonable until one remembers that at its nearest point to the earth Mars is some 30 million miles away, and that to make a reasonable display we should have to illuminate an area or a number of areas as large as, say, Australia.

"Ah," says the wild-goose chaser, "that depends upon the power of the Martians' telescopes," and to this we feel inclined to answer, "Quite so, but what about Reconstruction in the British Empire, and do you know that we still lack the perfect X-stopper"?

If the whole question be resolved into one of whether we can by wireless telegraphy transfer to Mars enough energy to admit of its detection there, then the answer is that this might be possible provided that we could attain the necessary radiation on a wave-length corresponding to a frequency somewhere between a million and a billion. This high frequency would seem to be necessary, in the light of our pre-

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sent knowledge, in order to make it possible for the waves to penetrate the Heaviside layer. Waves of an exceedingly small order of wavelength probably stand the best chance of traversing the layer, and we are not aware that any method has yet been devised by which they could be radiated with the requisite power and efficiency. From a rough calculation based on an adaptation of Austin's formula, and on the assumption that the amplitude of the waves would in interstellar space decrease according to the inverse square law, we think that to make a transmitter of the necessary power would not be outside present possibility.

SENATORE MARCONI'S VISIT TO LLOYD'S.

Senatore Marconi, who was elected an Honorary Member of Lloyd's on April 9th, recently paid a visit to that institution on the invitation of its Chairman. After being received by the last-mentioned gentleman (Mr. C. I. de Rougemont) and the Committee, he was conducted to the Underwriting Room and introduced as a newly-elected member. The Chairman, in the course of his speech, made reference to the beneficial results accruing from the introduction of wireless telegraphy.

Senatore Marconi, who wore the uniform of a Commander of the Royal Italian Navy, in his acknowledgment of the hearty reception he had received, said:—

> "I thank the Chairman of Lloyd's for his kind introduction and for the way in which I have been received. I need hardly say how greatly I appreciate the high and unusual honour of having been elected an Honorary Member of this old and illustrious Corporation."

Senatore Marconi was afterwards entertained at luncheon by the Chairman, at the City of London Club.

THE PROPHETIC TOUCH.

In an article entitled "Wireless Possibilities," published in the "*Year Book of Wireless Telegraphy and Telephony*" for 1918, Mr. A. R. Burrows wrote:—"There would be no technical difficulty in the way of an enterprising advertisement agency arranging for the interval in the musical programme to be filled with audible advertisements, pathetic or forcible appeals—in appropriate tones—on behalf of somebody's soap or tomato ketchup. Even to-day the departments of food economy and War Savings might provide periodic stentorian exhortations by wirelessly operated megaphones established at the traffic centres."

In view of this it is interesting to note a recent Reuter telegram from New York, which reads as follows:—"A striking feature of the Victory Loan celebration in Washington was the reading of President Wilson's Loan message from an aeroplane. By means of a wireless telephone and the newly-invented sound amplifier a crowd numbering about 15,000, assembled on the Treasury steps, heard distinctly President Wilson's words spoken through the air by an army aviator flying at a height of 2,600 feet."

GERMAN INGENUITY.

Many and amusing are the examples of "substitutes" which were evolved by the artful Teuton under the stress of the Allied blockade. The following description of the materials used in the construction of a wireless receiver is of considerable interest, not only because it furnishes yet another proof of how the "shoe pinched" in the Fatherland, but because it provides us with a record of experiments in emergency electrical material. According to the *Electrical Review*, ebonite, rubber and brass are

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conspicuous by their absence. The switches are mounted on slabs of three-ply wood, blacked over, and the coupling coils on tubes of papier-maché, the windings being insulated by silk only. The buzzer is mounted on stone-ware, and its leads are insulated with paper; all nuts and terminals are of gun-metal, and the dry cell is closed with four layers of cardboard instead of with pitch. The only ebonite used is on the switchboard, notably for the knobs of the handles. A few more years of war and the world might have been enriched with *ersatz* electricity!

ABSORPTION OF ELECTRO-MAGNETIC WAVES ON PARALLEL WIRES.

An account is given in the *Analen der Physik* by W. Arkadiew of the absorption of electromagnetic waves on two parallel wires. For the purposes of the experiment damped waves of wavelengths ranging from 72.7 cm. to 1.27 cm. were produced, and it was shown that the wave energy decreases exponentially as a result of absorption. A means of measuring the absorption co-efficient is given, and the writer also deduces a theoretical formula for calculating the velocity of propagation and the absorption co-efficients. The latter, for magnetic wires show a rapid fall of permeability towards the shorter waves. The permeability of various magnetic metals was calculated from the co-efficient of absorption and by extrapolation it was found that for iron the permeability should be unity at a wavelength of a few millimetres.

WIRELESS AND "WIND-JAMMERS."

By a royal decree of Feb. 20th, 1917, the installation of wireless on all Spanish vessels of over 500 tons was made compulsory. Enter Don José Maria Caballero Aldanore, owner of two sailing vessels of more than 500 tons, with a petition. He did not wish to fit wireless apparatus on his ships; they were sailing ships; he submitted that the decree should be left in abeyance. One gathers that Señor Aldanore is a wire-puller of discrimination and power, for another royal decree of February, 1919, enacts that the former decree shall be modified in the sense that sailing vessels above 500 tons, which habitually carry at least 50 persons, crews and passengers together, and which are engaged in lengthy voyages, shall be obliged to be equipped with only a "call station" (transmitter?) which can be manipulated by any member of the crew. So the worthy caballero has saved many pesetas. If he spent them on a wireless receiver and operator he might have the privilege of being the instrument, under Marconi, of saving lives.

It is a matter for wonder that so few sailing ships are provided with wireless telegraph apparatus, for all the arguments in favour of its use on steamers apply equally to such vessels. The small technical difficulties in equipping sailing ships have been met and overcome long ago.

THE PEACE TREATY AND GERMAN WIRELESS STATIONS.

Amongst the clauses of the Peace terms, which were handed to the German delegates on May 7th, is one relative to the future of German wireless working. For three months the stations at Hanover, Nauen and Berlin may not be used for naval, military or political messages without the assent of the Allied and Associated governments, but for commercial purposes only, under supervision. During the same period Germany is not to build any more high-power wireless stations.

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Digest of Wireless Literature

"UBER ROHRENSENDER."

By A. Meissner. Elektrotechnische Zeitschrift. 20.2.19. p. 78.

BY the method explained previously (*see* WIRELESS WORLD, *May*, 1919, *p.* 75) the curve shown on Fig. 11 was obtained for the anode current. When analysed into a Fourier series this curve will give:

$$i_A = 65.2\ Sin\ wt - 26.5\ Cos.\ 2wt + 8\ Sin\ 3wt + \ldots\ ^*,$$

the harmonics higher than the third being neglected.

The relative values of the amplitudes of the harmonics can be determined in a very simple way experimentally. The loop *S* (*see* Fig. 3**) is coupled for this purpose to a wave-meter, and the readings of the hot-wire (or any

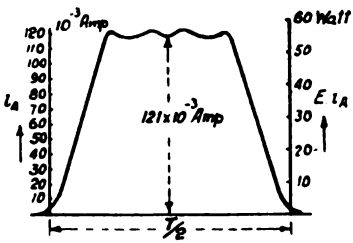

Fig. 11.

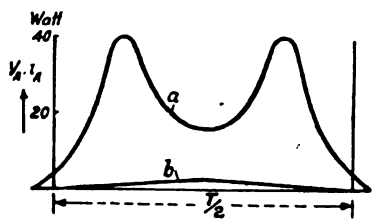

Fig. 12.

other integrating) indicator are observed, first for the fundamental and then for the higher frequencies. The relative position of the wave-meter with regard to loop *S* must remain constant during all the observations. Bearing in mind that the energy

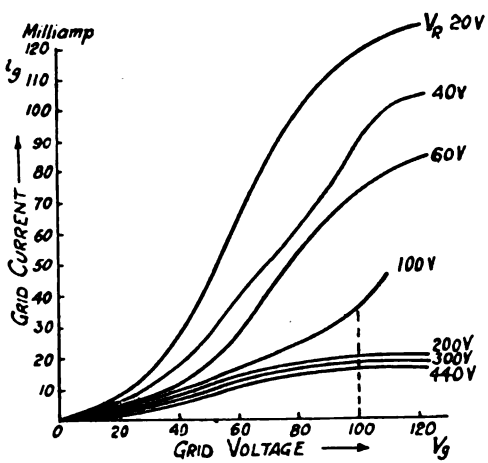

Fig. 13.

* The original paper has for the second term, probably an oversight, + 26·5 *Sin 2wt*.

** For figures 1–10, the reader is referred to WIRELESS WORLD, *May*, 1919, *p.* 75 *f.*

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transferred to the wave-meter is approximately inversely proportional to the squares of the various frequencies, we are at once enabled to evaluate the ratio between the amplitudes of the component oscillations. Thus, for instance, for the case considered the readings were:

1. For the fundamental frequency – 29
2. For the second harmonic – 17
3. For the third harmonic – 9

We obtain, therefore, for the ration between the amplitudes:

$$\sqrt{29} : \sqrt{\frac{17}{4}} : \sqrt{\frac{9}{9}} = 5{\cdot}39 : 2{\cdot}06 : 1 =$$
$$= 65 : 25 : 12$$

The losses in the valve will obviously be given by $i_A \times V_R$ (for values of V_R see Fig. 8) and are represented by curve "a" in Fig. 12. As to the losses in

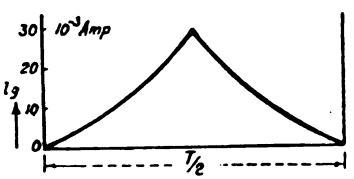

Fig. 14.

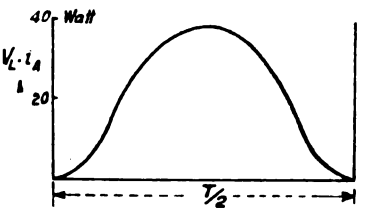

Fig. 15.

the grid circuit they are represented on Fig. 12 by the curve "b," which can be obtained from the grid-voltage and grid-current curves in the same way as curve "a." Fig. 13 gives the family of static grid characteristics, from which the grid-current curve shown on Fig. 14 has been obtained.

The energy consumed by the valve during the interval T, when current flows through it, will be given by the product of the applied constant voltage E and the

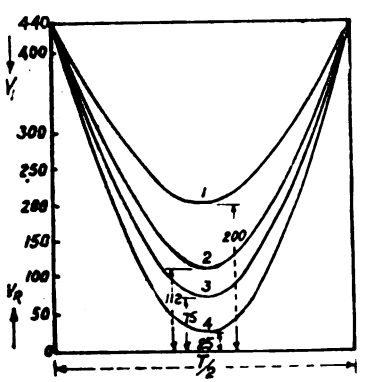

Fig. 16.

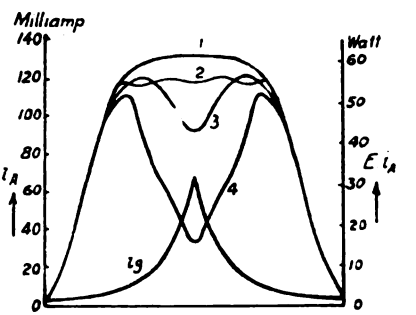

Fig. 17.

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anode current i_A. The curve thus obtained will be identical with that shown on Fig. 11. From the area enclosed by this curve and the horizontal axis, we obtain:

$$E\,i_A = \frac{41}{2} = 20{\cdot}5 \text{ watts.}$$

The readings of the instruments were:

$E = 440$ volts i (average) $= 48.10^{-3}$ amp.

which gives $Ei = 21.1$ watts.

The useful energy transferred to the oscillatory circuit can be obtained from the area inclosed by the curve and horizontal axis of Fig. 15, the ordinates of the

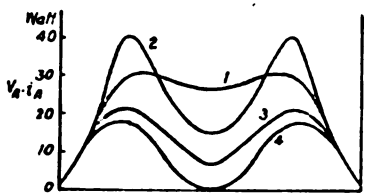

Fig. 18.

curve being determined for any moment by the product of the values of V_1 (*see* Fig. 8) and i_A (Fig. 11) at that moment.

For the valve under consideration, the useful output has been found by this method to be 11.5 watts.

This result was checked by direct measurement of current and resistance. This gave:

$$I^2_{eff} \times R = .86^2 \times 17.5 = 11.5 \text{ watts}$$

We can now find the efficiency of the arrangement. It will be seen that it amounts to:

$$\eta = \frac{11{\cdot}5}{20{\cdot}5} = 56\%$$

or, if 21.1 watts, the figure obtained by direct measurement of the input, is taken:

$$\eta = \frac{11{\cdot}5}{21{\cdot}1} = 54{\cdot}5\%$$

The author investigates next the question of how a variation in the value of L (Fig. 3) will affect the arrangement. Fig. 16 gives a series of curves for

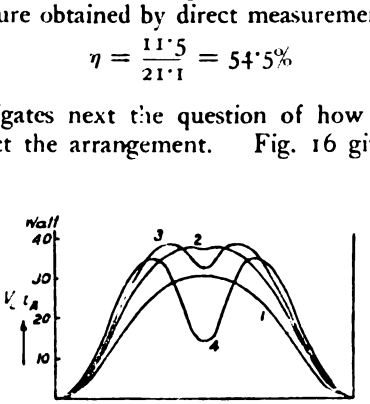

Fig. 19

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V_L max. = 415, 365, 328, and 240 volts, corresponding to different values of L. The values of V_K can be read off in the same manner as in Fig. 8. Assuming the same grid voltage (V_g max. = 102 volts) we can obtain from Figs. 16, 9 and 10 the family of curves for the anode current as shown on Fig. 17 in the same way as Fig. 11 was obtained. The curves for the losses in the tube and for the useful energy transferred to the oscillatory circuit II (Fig. 3) are given on Figs. 18 and 19 respectively.

An inspection of these figures shows that for small values of V_L (*e.g.*, curve 1) the anode current rises, the losses in the tube are comparatively large, while the energy delivered to the oscillatory circuit is comparatively small. The efficiency of the tube will therefore be low.

For large values of V_L (curve 4) the anode current and therefore the input energy fall, the losses in the tube decrease and are concentrated in the first and last thirds of the half-cycle, the output falls also, but not considerably. The

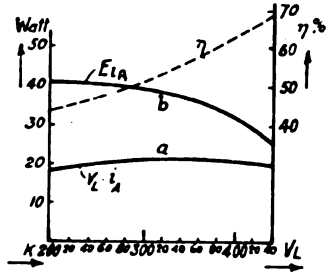

Fig. 20.

efficiency of the tube is good, but the output is not the largest which can be obtained from the tube.

The results obtained are shown on Fig. 20, where the variations of input (curve *b*), output (curve *a*) and efficiency (curve η) are given as functions of V_L.

It will be seen that from the point of view of the best utilization of the valve, L must be so chosen as to give a value of V_L max. about 30 per cent. smaller than the applied constant voltage "E." This adjustment does not coincide with the point of highest efficiency.

In conclusion the author states that an investigation similar to the foregoing, but with constant V_L and variable V_g has shown that the best results were obtained for V_g max. = 102 volts. The tests show that generally the efficiency of the tube is higher for small values of V_g than for larger. At the same time, however, the output begins to decrease if the coupling between plate and grid circuits is made too small. Therefore, in this case also the best adjustment will not occur at the point of highest efficiency.

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Time from a Wireless Point of View.

By E. J. Wagstaff.

WHAT is Time? Little more than the duration of existence arranged on an arbitrary basis for the ordering of men's lives and actions. It has been from time immemorial the rule to utilize the (apparent) movements of the sun for its measurement, and it has been always and everywhere accepted that noon, the period when the sun stands at its highest place in the heavens, shall be the starting point for calculation.

Now this meridian varies in different parts of the world, indeed its variation starts the moment one passes east or west of the point selected for the solar observation. So long as the eastward or westward distances are not great, it is found convenient to ignore these comparatively small divergencies and establish what is called a Standard Time. Thus English Standard Time regulated on the meridian of Greenwich is applied, not only to the British Isles, but to France and other countries situated round about the longitudinal line which passes through Greenwich. The Central European countries, lying considerably eastward observe a Standard Time based upon a meridian 15° east of Greenwich. Similar variants exist west of Greenwich, and so on through the other quarters of the globe.

Until steam traction on Sea and Land brought the world closer together, these arrangements answered fairly well. Now that steamship and railway

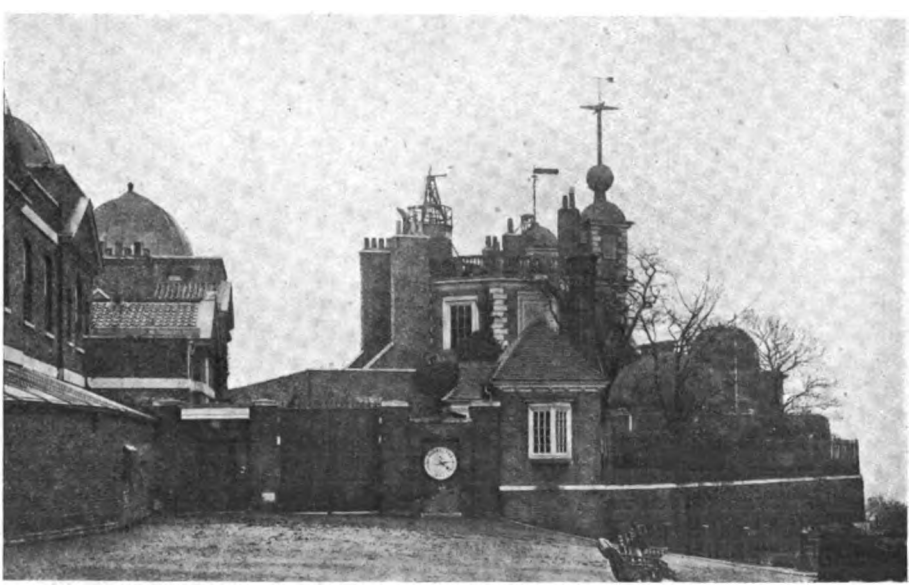

Photo: Courtesy, Astronomer Royal.

A view of the Royal Observatory at Greenwich, with the clock from which G.M.T. is taken.

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development has been intensified by practice, and supplemented by the advent of aviation, and now that radiotelegraphy has provided a messenger equal in speed to the light of the sun, some change in the method of registering time has become a matter of urgency.

The systematization of time-measures was first undertaken from a land point of view, and in 1883 European experts agreed to select Greenwich as a universal basis; whilst in the following year a conference at Washington ratified their choice and drew up a system of universal time. But up to a recent date, despite the fact that three-quarters of the globe is covered by water, time at sea has been left in its traditional confused condition; so that when we receive a radiotelegram from a ship at sea, and observe its date and the time at which it was handed in, we are faced with the problem:—Does the entry there recorded mean: (a) Greenwich time, (b) Local time, (c) Ship's time, (d) Standard time, or (e) Summer time?

This item in the message might easily become of supreme importance. The man in charge of a business house might have wirelessed to his Principal at sea, giving certain information and asking for instructions. Under present circumstances it is possible for him to receive a radiotelegram which—judging from the times therein recorded—was an answer to his enquiry; but which might in reality have crossed his own message and been despatched in total ignorance of the information contained therein. Again, take the case of births and deaths at sea; it may be of extreme moment, from the point of view of inheritance and other considerations, to know the exact hour at which a child was born, or that at which some one on board ship breathed his last. Moreover, weather and meteorological problems depend largely for their solution upon the time at which the phenomena connected with them are observed and telegraphed. Travel on land, sea, and air grows ever more and more, and it is becoming increasingly evident that time at sea is of as great importance as time ashore.

A system of zones appears to offer the most hopeful solution of the problem.

Radiotelegraphy has brought ships at sea into continuous touch with land and with other ships, and has in consequence simultaneously added insistence to the problems and afforded opportunities for its solution. The French Ministerial Circular, dated 22nd March, 1917, laid special emphasis upon this fact. That memorandum was issued with the object of "Setting forth the Notation of Time at Sea after the Fashion of Zone Times," and was closely followed by a Conference held at Whitehall between the 21st June and the 3rd July, 1917.

As a result, the British Admiralty put forward a proposal for zone time at sea, advocating the establishment of 24 zones, with Greenwich as the zero, and the other zones numbered westward + 1 + 2, etc., eastward − 1 − 2, etc. In this proposal it is left optional to the Commander of each vessel to alter his ship's time-piece in accordance with his convenience in working the vessel, and the suggestion is made that for the despatch or reception of radiotelegrams, etc., either zone time should be used or that of Greenwich. The latter suggestion does not meet the exigencies of the case, and—whatever may be the practice adopted by the Commander of the vessel so far as his working time on board is concerned—it would appear essential that the clock in the wireless room should be changed the moment the zone limit is crossed, so that all radio working should be kept

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strictly to zone time. Under present circumstances no provision is made in radiotelegraph regulations for fixing the time standard utilized in wireless telegraph working, and only such a course as that just recommended can obviate the confusion and uncertainties which are almost inevitable under present conditions.

The rule hitherto observed is for the ship's wireless operator to use G.M.T. when working with other ship stations, and the coast station time when working with coast stations; an arrangement obviously impracticable now that the wireless telegraph service is being developed in all parts of the world. We may exemplify this impracticability by considering the case of a vessel working the Australian Coastal Service. Here a local standard time would be in use, and if the operator on a British Trans-Oceanic steamer were, in his communication with the Australian ship, to utilize G.M.T. for entering time particulars, as required on the message form ("Time handed in"), the addressee might not improbably be surprised by finding that—on the face of the telegram—he received his message before it had been handed in at the point of origin. Of course such an anomaly might be defended by the explanation that the entry of the time comprises an unpaid telegraph service instruction, and that therefore a discrepancy of this nature would be immaterial. In view, however, of the fact that the entry appears on the telegram as handed to the addressee, such an explanation could hardly be considered satisfactory, or indeed other than detrimental to the Public Telegraph Service. How is any member of the public to differentiate between what is intended for him and what is not?

The suggestions which the present writer would put forward are:

1. That (as indicated above) zone time should be strictly adhered to in all radiotelegraphic offices afloat and ashore, ship's time being corrected the moment the vessel crosses from one zone to another.
2. That all radiotelegrams should bear the zone time of the station of origin; in the case of messages emanating from ship stations the time should be supplemented by the zone number with the indication E. (East) or W. (West).
3. When the radiotelegram arrives at the final wireless handling office, such time should be amended and expressed in the standard zone time of the receiving station (a matter which under this system would be perfectly simple). This suggestion applies particularly to messages exchanged between ship and ship, and from ship to shore, it being in such cases that ambiguity usually arises with regard to time.
4. The time entries inserted in the Operator's log of communications should be made on the zone standard, a clear indication being shown of the moment when the wireless office clock is advanced or put back one hour, as the ship passes from one zone to another. By this means it will be possible to identify *exactly* the time of any event noted in the ship's records.
5. General use should be made of the Continental method of indicating time on the 24-hour principle, which obviates the insertion of a.m. or p.m.

In exemplification of (3) let us take a message handed in at noon on board a ship at sea within zone 1W, and transmitted to the Wireless Station at Valentia (zone G.M.T.). This message would be amended by the Coast

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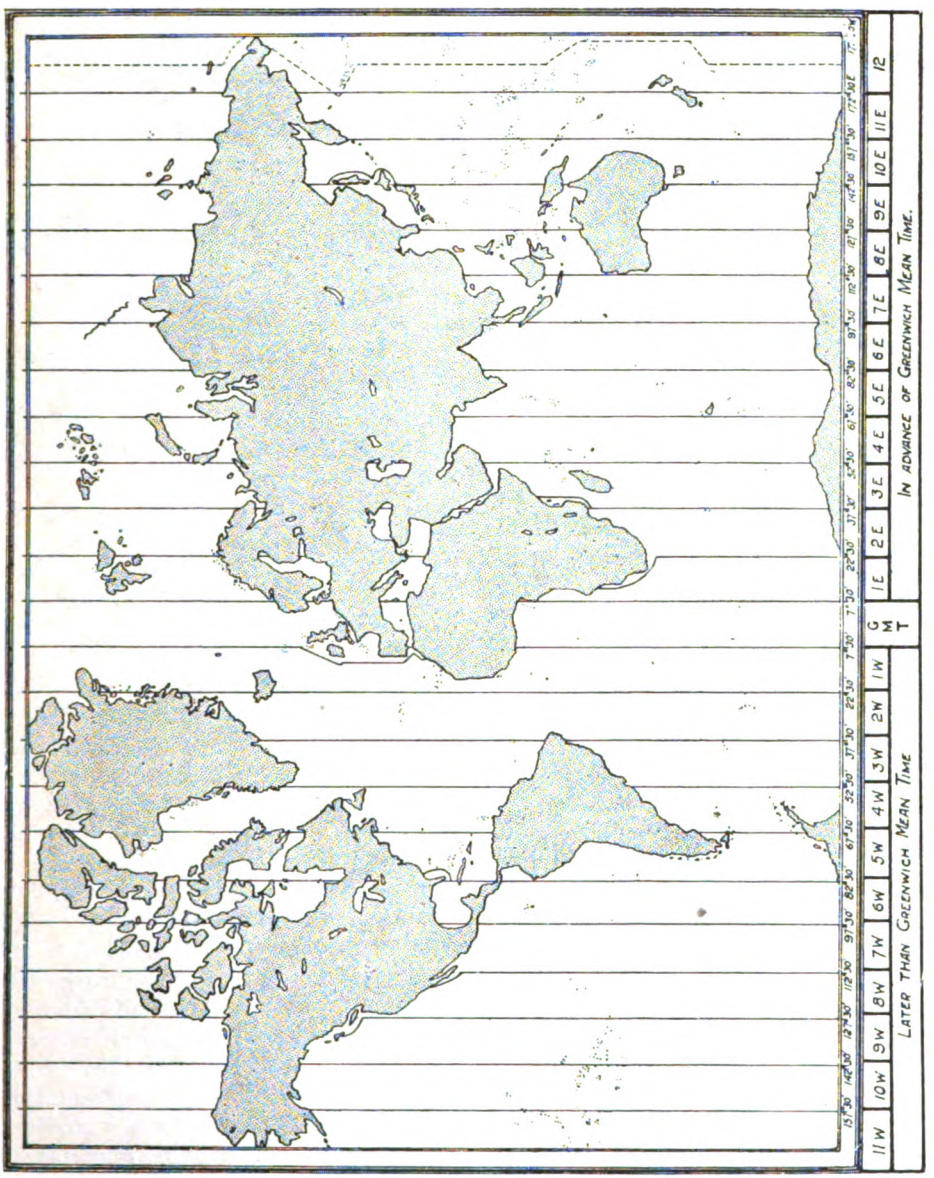
LATER THAN GREENWICH MEAN TIME
11W 10W 9W 8W 7W 6W 5W 4W 3W 2W 1W
G M T
1E 2E 3E 4E 5E 6E 7E 8E 9E 10E 11E 12
IN ADVANCE OF GREENWICH MEAN TIME.

Map of the World showing suggested division into Time Zones.

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Station Operator, as far as time is concerned, before being passed to the Land Lines for delivery; so that the "Time handed in" should read "1300." (G.M.T.). Where the final wireless handling office is a shore station in a country utilizing summer time, allowance would be made in the adjustment for this arrangement.

In order to illustrate the working of this time zone proposal, a map has been prepared showing the world on Mercator's projection divided off into 24 longitudinal zones of 15° each, the time difference between one zone and another being therefore one hour. Greenwich has been taken as the central point, and—following on the lines of the Admiralty proposal—the Central Zone (wherein is adopted Greenwich mean time) stretches from 7°.30′ west to 7°.30′ east. The other zones are numbered 1W, 2W, etc., 1E, 2E, etc., according to whether they lie west or east of the Central Zone. It will be noted that the zone lines are not continued across land areas because our proposal is essentially one for wireless time at sea, and there are certain complications ashore into which it is needless for us to enter here. We refer to such matters as the possible desire on the part of countries like India and New Zealand for establishing an Intermediate-Zone Standard Time to suit their own requirements.

The emission of time signals by radiotelegraphy in all parts of the world offers a ready means for standardizing time. Most of these signals are based on G.M.T., and by the adoption of a systematic sixty-minute time zone all calculations in relation thereto are simplified and time can be regulated with precision.

At present stations nearby or widely separated use time adjusted on different standards and on standards which are frequently unknown to each other. The general introduction of radiotelegraphy has emphasised these shortcomings and enhanced the need for standardization.

Only by a system such as outlined above can stations ashore and afloat eliminate misunderstandings with regard to time and maintain their entry records on a universally accepted standard.

In order to obtain the fullest advantage from the procedure above set forth, it would be necessary to secure its adoption throughout the whole world. The disadvantage which attends any deviation from International Convention Regulations on the part of any important country, may be exemplified from the fact that, although the United States and Canada ratified the International Radiotelegraph Convention of London, they have hitherto found themselves unable to give effect to one or two of its provisions. Amongst those affected by this reservation, is the one which relates to the entry on the radiotelegram of the time at which it is handed in at the point of origin. The custom in those two countries has hitherto been for the Land Line telegraphist to insert the time at which the message was received by the Land Line from the Coastal Receiving Station, a practice which has led to considerable confusion and inconvenience.

Such a uniformity of regulation and working can only be effected through the medium of the International Convention. Rapid progress in wireless working, and the increased facility with which Radiotelegrams are now handled, renders the meeting of such a conference a matter of extreme importance, and it is to be earnestly hoped that amongst the matters towards which the delegates' attention is directed, may be a most serious consideration of the question of time-keeping from a wireless point of view.

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Notes of the Month

MARITIME COMMERCIAL WIRELESS TELEGRAPHY.

As from May 1st, 1919, all restrictions on the use of Wireless Telegraphy at sea are cancelled except in regard to ships when in the North Sea, English Channel (east of a line joining Dungeness and Boulogne), the Baltic and Northern Russian waters, the Mediterranean Sea, Black Sea and Sea of Marmora.

WIRELESS OPERATORS AND B. OF T. EXAMINATION.

An amendment to the Board of Trade Regulations concerning the examination of masters and mates reads as follows:—"If a candidate has been engaged on articles of agreement as seaman, or in any seaman rating, and has served both as a seaman and as a wireless operator, the service may be counted as qualifying service in full." Also, "If a candidate has been engaged on articles of agreement as a wireless operator, and has served as such, one quarter of the service up to a maximum of twelve months may be counted as qualifying service." On the grounds that this arrangement will tend to overcrowd a profession, the ranks of which are already well-filled, the Council of the Mercantile Marine Service Association have registered a protest against the amendment.

FRENCH OVERSEAS WIRELESS STATIONS.

According to the *Revue Générale de l'Electricité*, there are 35 French wireless stations at work, exclusive of those in France; 25 are being constructed, and 20 more are projected. Included in this scheme are stations for Algeria, the Congo, Timbuctoo, Madagascar and Indo-China.

MR. JOSEPHUS DANIELS IN ROME.

Christopher Columbus discovered America. Mr. Josephus Daniels, Secretary of the United States Navy, recently returned the compliment, and whilst in Rome said in the course of a speech: ". . . . . We shall never forget that it was your Marconi, a distinguished member of the Italian Mission in 1917, who first caused the electric spark to radiate freely into space, in obedience to the will of man, in such a way as to transmit the messages of mankind across space and over all obstacles without the help of an electric cable. It is because of the daring of his inventive genius that our ships are now able to speak to each other across hundreds and even thousands of miles of ocean, and that time and space have been abolished in so far as concerns the communications of man with man."

WIRELESS INVESTIGATIONS OF THE SOLAR ECLIPSE OF MAY 29th, 1919.

Shortly after the issue of the present number of the *Wireless World* certain experiments on the effect of the forthcoming eclipse on signals transmitted across the zones, will be carried out under arrangements made by the British

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Association Committee for Radiotelegraphic Investigation.

During the eclipse various wireless telegraph stations will emit signals consisting of letters of the alphabet changed according to a definite plan at the end of each minute; the programme of letters is so arranged that no two come together in the same order more than once. They will be accurately timed at selected receiving stations. On the day before the eclipse the stations will send practice signals for a short time near noon (Greenwich Mean Time). The stations at Ascension and the Azores will transmit during the transit of the umbra across the Atlantic, receiving stations north of the Equator being detailed to listen to Ascension, whilst those south of the Equator will observe the signals from the Azores. The receiving operators will denote the signal strength on a scale from 0 to 9. Certain pairs of stations such as Darien and Falkland Islands, and an Egyptian station and a South African station, will, it is hoped, conduct special experiments. One of the aims of the scheme is to clear up the problem of the effect of the changes of the ionisation of the air on long and short waves. For further information application should be made to Dr. W. Eccles, Hon. Sec. of the Committee, City and Guilds Technical College, Leonard Street, E.C.2.

WIRELESS CLUB NOTES.

On April 2nd the Three Towns Wireless Club of Plymouth met, the chair being taken by Mr. Boniface, who represented Major Malden, a Vice-President of the Club. Mr. Lowe performed a series of experiments illustrative of electro-magnetism and the application of electricity to daily life. On April 9th the Chairman was Mr. J. Jerritt. The meeting was devoted to instructional purposes, election of new members, etc. It was announced that Sir A. Shirley-Benn had consented to become a Vice-President. The subject of the lecture on April 16th was Wireless Telegraphy, the lecturer being Mr. Voss, an ex-instructor in the Air Force, who carried out his task in an able and interesting manner.

Applications for membership of the Club should be addressed to the Hon. Sec., Mr. W. Rose, 7 Brandreth Road, Compton, Plymouth. Corresponding members are invited to join.

The Wireless Institute of New South Wales decided recently to link up all the experimental associations in Australia, with the view of forming a national association of amateur wireless experimenters and users.

We are requested by Mr. A. W. Knight, of 26, Stanbury Road, Peckham, S.E.15, to state that he will be glad to hear from anyone who is willing to act as Organiser or Secretary to a projected Wireless Club for S.E. London (Dulwich, Peckham and Camberwell). Stationery, membership cards, books and apparatus are available.

DUBLIN MUNICIPAL WIRELESS COLLEGE SOCIAL.

On April 14th, in the Art Room, Kevin Street, there took place a social and dance of the students of the Dublin Municipal Wireless College. The guests included Mr. L. E. O'Carroll (Secretary, Technical Schools), Mr. W. J. Lyons (Principal, Wireless College), Messrs. Smyth, Hodgens, McAteer, O'Kelly and Feely (Wireless Instructors), and Mr. D. Soraghan (Editor of "Billi Condenser," the College Journal). A highly successful feature of the evening was Mr. Harvey's exhibition of characteristic curves to the accompaniment of Mr. Johnston.

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Heterodyne Envelopes.

By J. St. Vincent Pletts

WHEN a received oscillation is heterodyned, that is to say when it has superimposed upon it a locally generated alternating current of a different frequency, a pulsating oscillation is produced, and it is the magnitude, frequency, and shape of this pulsation which determines the interference or beat note heard in the telephone when the pulsating oscillation is rectified. The note heard, therefore, depends entirely upon the envelope of the pulsating oscillation, or upon what may be called the heterodyne envelope, which is here investigated.

If the received oscillation be due to a continuous wave it may be represented by :

$$a = A \sin pt$$

while the heterodyne current, if assumed to have the same phase when $t=o$, may be represented by :—

$$b=B \sin(p \pm q)t$$

Putting these in the form of vectors it will be seen from Fig. 1 that, if $DE=A$ and $EF=B$, the maximum amplitude at $t=o$ is given by $DF=A+B$, and that

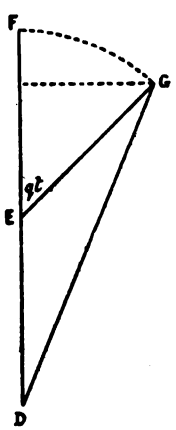

Fig. 1.

at some later time t the vector B will have turned to EG through an angle qt relatively to the vector A, giving the maximum amplitude $DG=C$. Now :—

$$(DG)^2=(A+B \cos qt)^2+(B \sin qt)^2$$

so that the equation for C, which is of course the equation for the heterodyne envelope, becomes :—

$$C=\sqrt{A^2+2AB \cos qt+B^2}$$

In Fig. 2 I have drawn these envelopes for values of B one, one and a half, two, three, and five times A, and it will be seen that they vary from a succession of half sines at equality to a nearly pure sine of twice the frequency when B is five

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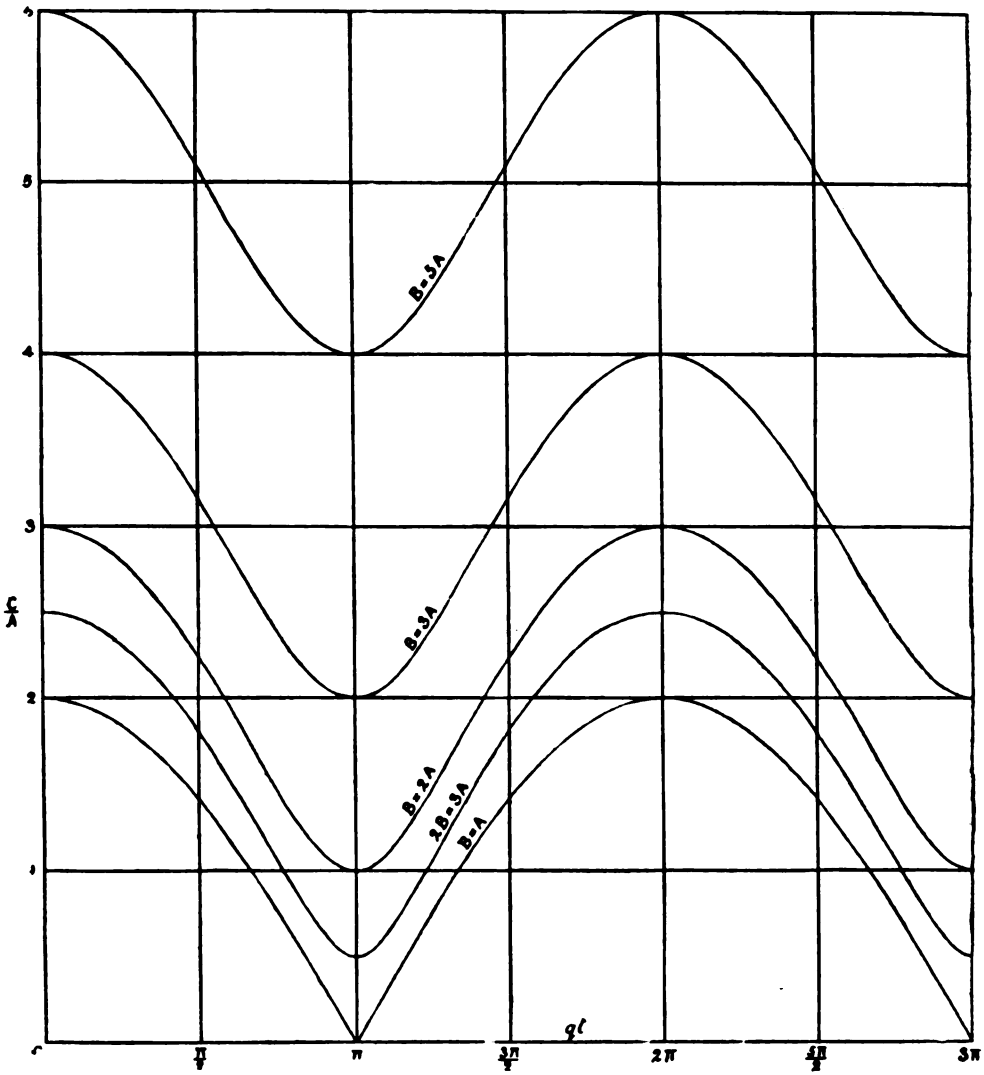

Fig. 2.

times A. That the envelope is a succession of half sines at equality is seen at once from the expression for C, since if $A=B$:—

$$C=A\sqrt{2(1+\cos qt)}$$
$$=\pm 2A\cos\tfrac{1}{2}qt$$

But it is evident that the upper half can, like all the other envelopes, be expressed in the form:—

$$C=BC_0+AC_1\cos qt+AC_2\cos 2qt+AC_3\cos 3qt+\cdots$$

The curves in Fig. 3 give the values of C_0, C_1, C_2, C_3 and C_4, for values of B from one to five times A, and it will be seen that the harmonics, which are at

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first fairly large, rapidly diminish, until at $B = 5A$ the envelope is very approximately represented by:—

$$C = A\ (5 \cdot 1 + Cos\ qt - \cdot 1\ cos\ 2\ qt)$$

so that the note is the fundamental with its octave of a tenth the strength. The more B is increased relatively to A the nearer does the envelope approximate to:—

$$C = B + A\ cos\ qt$$

and the purer does the fundamental note become. It will also be seen that the

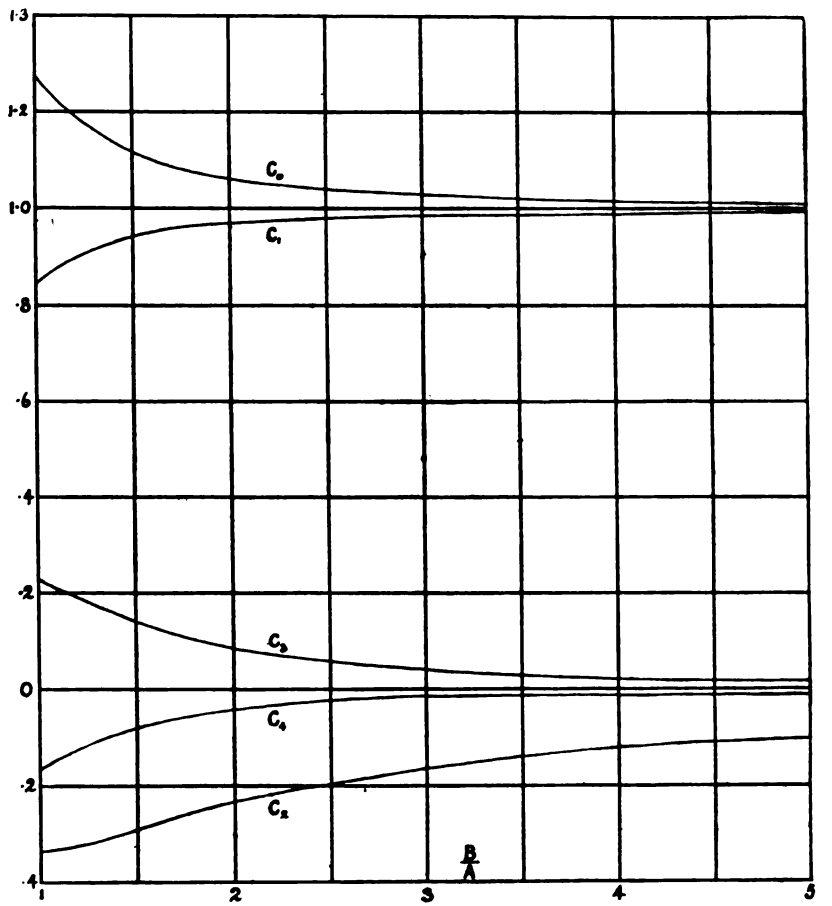

Fig. 3.

amplitude of the fundamental note is only 84% of the maximum at equality, and that it asymptotically approaches A as the ratio of B to A is increased, so that the fundamental note can be strengthened nearly 20% by increasing the heterodyne current.

The same law holds when the amplitude of the heterodyne current is less than that of the received oscillation, but such an arrangement is inefficient as the amplitude

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of the note is then limited to that of the heterodyne current. This limitation might perhaps be made use of in the case of strong interfering signals, for a small heterodyne current would reduce the notes to equality of strength so that they could be separated out in circuits tuned to the beat frequencies.

Damped oscillations can also be heterodyned, and (still assuming coincidence of phase when $t=o$) the equation for the envelope then becomes:—

$$C = \sqrt{A^2 e^{-2\delta t} + 2AB e^{-\delta t} \cos qt + B^2}$$

where δ is p times the decrement per period of the received oscillation. In Fig. 4 I have drawn the envelope for the case where $A = 2B$ and $\delta = \frac{q}{3\pi} \log 2$, so that the amplitudes are equal at the moment when they come into opposition for the second time. It will be seen that the envelope starts as a wave of constant

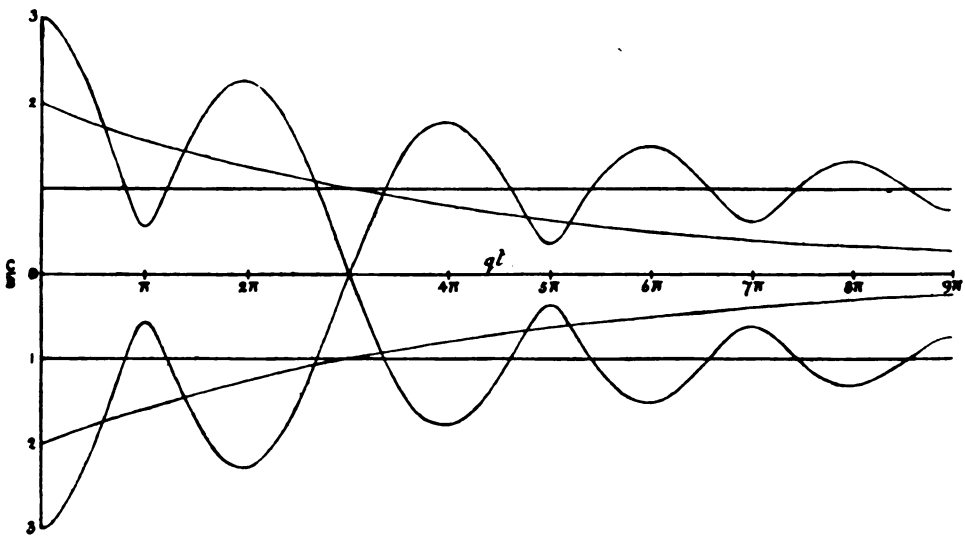

Fig. 4.

amplitude and increasing impurity on top of a decreasing current, but after passing through zero becomes a wave of decreasing amplitude and increasing purity on top of a constant current, and finally dies out as a pure sine ripple on the rectified heterodyne current.

As every rectified current can be expressed as a series of the form:—

$$C = A_0 + A_1 \cos pt + A_2 \cos 2pt + A_3 \cos 3pt + \cdots$$

or:—

$$= \sum_{o}^{n} A_n \cos npt$$

it is obvious that the value of the current for the purpose of, say, charging an accumulator is A_0; but I do not think it is as generally recognized that the value for, say, heating the filament of a lamp is quite different, or in other words that the C^2R losses are not equal to $A_0^2 R$. Indeed it generally causes some surprise that with the arrangement shown in Figure 5, where independent sources of direct and alternating currents are connected to a common resistance R, the reading of the

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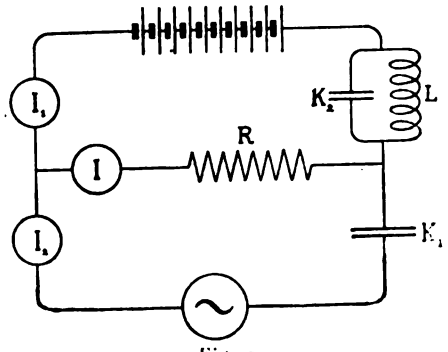

Fig. 5.

ammeter I, whether it be a direct or alternating current instrument, does not equal the sum of the readings of the ammeters I_1 and I_2, although the condenser K_1 and the blocking circuit LK_2 prevent the passage of any direct and alternating current through them respectively. The heating value of a rectified or other varying current is given by :—

$$C_{RMS} = \sqrt{\frac{p}{\pi}\int_0^{\frac{\pi}{p}}\left(\sum_0^n A_n \cos npt\right)^2 dt}$$

$$= \sqrt{A_0^2 + \tfrac{1}{2}\sum_1^n A_n^2}$$

so that the R.M.S. value of a varying current is the root of the sum of the squares of the R.M.S. values of all the constituent harmonics, including the direct current component.

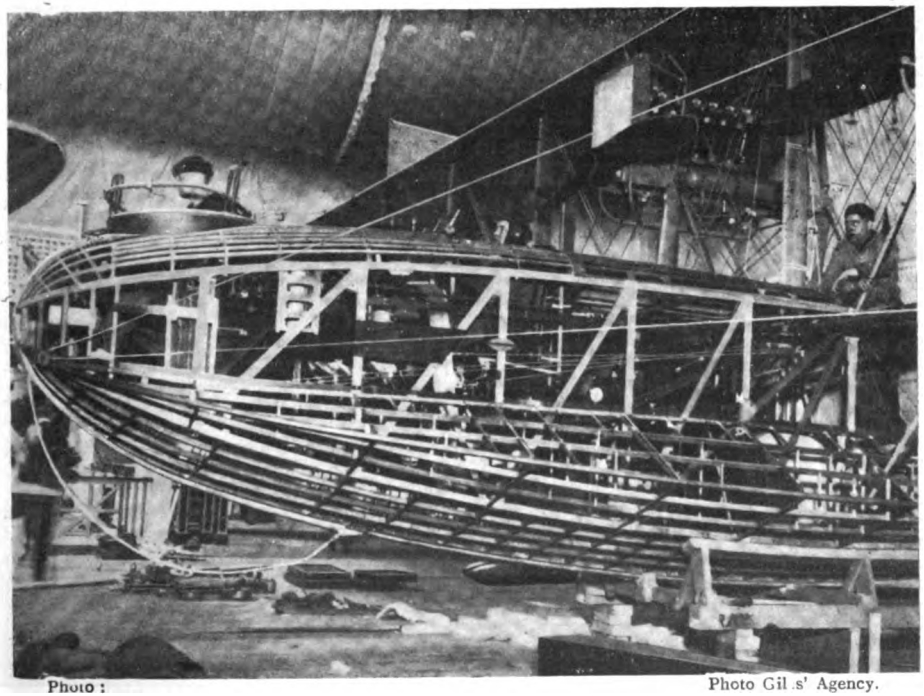

Photo : Photo Gil.s' Agency.

Fuselage of a flying boat showing operator with special headgear for wireless telephony.

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Correspondence

THE AMATEUR POSITION.

Up to the time of going to press no announcement relating to the lifting of the ban upon private wireless work has been made by the authorities. Nevertheless, we entertain strong hopes that by the time our next number appears amateurs will be busy with aerial-erection and the furbishing-up of their long-lost coils and condensers. We base our hopes upon the indication afforded by the gradual disintegration of D.O.R.A. The restrictions on the use of maritime W/T are now removed to a certain extent, and many prohibitions on trading have been rescinded; hence, with the Peace Treaty signed, there should ensue sweeping movements towards pre-war conditions.

We publish this month another letter in defence of amateur rights and should like to direct attention to a remark alleged to have been made by Captain H. R. Sankey, which is reported therein, to the effect that no case had been proved against any amateur station in respect to interference with Government stations. Although we think the writer is in error in attributing it to Capt. Sankey, yet we believe it to be a perfectly accurate statement, so far as stations in Great Britain are concerned, up to the outbreak of war, and we trust the authorities to bear it well in mind.

To the Editor of the WIRELESS WORLD.

DEAR SIR,

Re your wish in the March issue of your valued magazine (THE WIRELESS WORLD) for opinions from amateurs relative to the permission for the re-organisation of amateur Wireless Stations. I myself endorse the opinion of the writers of the articles published by you in this edition. I with many others bitterly lamented the closing down of our Radio Stations and consequent stagnation to our researches which were to some of us our very life. No order could have been more bitter to us than the order to dismantle our stations and shelve the work which was our heart's desire. Reverting back to the plea for amateur rights, I myself am fully convinced that many amateurs have earned the right to expect full permission to restart the work which was their best pleasure, after putting their capable services to their country's benefit, as operators, constructional radio engineers, etc., and I am persuaded that many now who are still in their King's service will be utterly disappointed on return to civil life should their life's hobby be refused them. I myself have not been able to do anything in direct service for my country, as my younger friends have done, but I pride myself on the fact that I have been instrumental in helping many men into the service of the Marconi Mercantile Marine Service, who on declaration of war subsequently served their country on mine sweepers, secret ships, and armed merchant cruisers, and in other capacities. One member of my firm in the textile fabric branch, is now 2nd-Lieut. in the R.A.F., Egypt, wireless engineer in charge through my personal aid, and many others of our ranks have been able in some way to indirectly help our country by their knowledge of wireless telegraphy. Some of our best young wireless enthusiasts have given their life for their country, of whom I may mention Mr. Halliday Findlay of Parsons Green, S.W., a personal amateur friend of mine, who's young life was sacrificed on the sinking of the Aboukir in the early stages of the war. Surely, the amateur wireless telegraphist has earned the indebtedness of his country at large, and a right to claim once more freedom to enjoy that for which he was willing to stake his life. With regard to amateur interference, I don't remember whether Dr. Eccles was at the inaugural meetings of the Wireless Society of London at Westminster Schools, but no less an authority than Capt. H. Riall Sankey told us that he congratulated the many wireless amateurs present that no case had ever been proved against any amateur stations interfering with any Government or other station. I trust that our combined testimonies may through your valued columns, which have done so much to encourage us in our work of love, prove to give us those liberties once more which to us are so dear.

Yours faithfully,

(Signed) W. J. FRY, Engineer, Maple & Co., Ltd.; late Committeeman, Wireless Society of London.

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Practical Notes on the Use of Small-Power Continuous Wave Sets

BY J. SCOTT-TAGGART, M.S.Belge E., A.M.I. Radio E.

Continued from May Number, page 93.

The fault may be due to any of the following reasons:—

(*a*) The coupling between *R* and *L* may not be adjusted correctly; it is possibly too loose.

(*b*) The high-tension voltage may not be high enough.

(*c*) The insulation of the aerial or the set may be faulty.

(*d*) The value of the filament current may be too low.

(*e*) The connections of the valve, or the valve itself, may be faulty.

In order to make the valve oscillate, it is, therefore, necessary to look to these points. Possibly the valve has stopped oscillating owing to the accumulator having run down somewhat, in which case all that is necessary is to increase the filament current until a click is heard, indicating that the valve has begun to oscillate again.

The value of the filament current and high-tension voltage should be as small as possible because, even when receiving, the set is emitting waves which, if made unnecessarily strong, will cause interference with other stations.

Once the valve is oscillating, it is necessary to tune the set in to the transmitting station. This is done by varying the inductance and condenser C_1 until the station is heard. On turning the condenser round a "chirp" is first heard, which, when analysed, as described above, consists of a high note dropping to nothing and then rising again as the receiving condenser is turned. The note can therefore be varied at will and either side of the silent interval may be used. If one side is being "jammed" by another C.W. station, the other side should be used. Only the loudest signals can be obtained by trying different combinations of filament current, reaction coupling, high-tension voltage, inductance and capacity.

An aerial of great capacity, for example, will need a higher value of high-tension voltage, or filament current, or reaction coupling in order to make it oscillate. It will generally be found that the best results are obtained when the valve *just* oscillates. This condition may be obtained by gradually loosening the coupling or reducing the filament current. In order to keep this critical point it is advisable to use an accumulator of considerable capacity, so that there is no likelihood of signals being suddenly cut off when the voltage of the accumulator drops. It must be remembered that, in reception as well as in transmission, when the reaction coupling is varied in order to obtain the loudest signals, the wave-length also is varied slightly at the same time, and it will be necessary to compensate for this by a slight returning of the condenser C_1. The selection of a good valve is also advisable if the best results are desired. A softer valve than the one used for transmission will generally be found most suitable. A valve having similar characteristic curves to those given by

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the writer in the Paper on "Valve Characteristic Curves"* will be found suitable for transmission or reception.

In order to adjust the receiving circuits so as to ensure hearing the transmitting station without unnecessary waste of time and uncertainty, a heterodyning wave-meter is necessary. The wave-meter described above may be used as a transmitting or receiving instrument. If the condenser of the wave-meter be set to the wave-lengths being transmitted it will radiate feeble waves of that length, by which the receiving set may be tuned. It may frequently be desirable to know the wave-length on which a certain station may be working. In order to do this the receiving apparatus is tuned until the distant station is heard. The note-frequency of the received signals may be varied at will, and for the present purpose the apparatus should be tuned so that nothing is audible in the receivers, and yet, if the tuning be varied either way, the distant station will be heard. When this condition is obtained, the frequency of the local oscillations generated by the valve is equal to the frequency of the incoming waves. If a wave-meter be now brought near to the receiving instrument the feeble waves emitted by the latter can be accurately measured in exactly the same manner as described above. The length of these waves is the same as that of the waves from the distant station.

When a central station has to work to two or more other stations at the same time, the wave-meter again proves its usefulness. Owing to the very fine tuning, it is somewhat difficult to arrange to receive the replies from a number of stations without making a re-adjustment for each station. It can, however, be done by deciding to make all the stations adjust the condensers of their transmitting sets so that the silent intervals of all their signals coincide on one point on the receiving condenser. If the silent interval of one of the stations is found, for example, to be five degrees further up the condenser than the other stations, the station at fault should be informed of the fact and told to reduce the value of his transmitting condenser five degrees. After one or two corrections, the silent point of his signals can be made to coincide with the silent intervals of the other stations, and therefore all the stations can be heard on the one adjustment, which, of course, is a little to one side of the silent interval. If desired, the incorrectly tuned station may be told that he is working on a wave-length so many metres "out." The wave-length of the controlling station may be checked by one of the other stations.

This system is preferable to checking wave-lengths by means of wave-meters. The following method, however, is useful. The controlling station sends out on the true wave-length. The remaining stations tune their sets so that the silent interval is obtained. The receiving circuit is now emitting feeble waves of exactly the same length as those of the control station. Each station then listens on his wave-meter and adjusts it until the silent interval produced by these feeble oscillations is obtained. The operator then presses the key of his sending apparatus, and, still listening on his adjusted wave-meter, moves the transmitting condenser round until the silent interval is found. The transmitting station will now be working on exactly the same wave-length as the control station.

It will be recognised that, since the tuning appears less fine, the longer the waves used the more easy is it for a

* *Vide* "Valve Characteristic Curves and their Application in Radiotelegraphy," THE WIRELESS WORLD, September and October, 1918.

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number of stations to work between themselves, or for a central station to call up several stations at the same time. Since stations are liable to miss calls unless tuned absolutely correctly, it is often advisable for the transmitting station to depress his key for a moment and to vary his transmitting condenser once or twice a very little to either side of the correct adjustment. This saves the receiving operator the trouble of continually varying his adjustment while listening-in; he listens on the normal adjustments, and when his attention is drawn to the momentary "swish" of the transmitting station he tunes his set accurately.

Since heterodyne reception proves efficient for damped as well as continuous waves, considerable interference by spark stations is liable to occur when using the circuit of Fig. 5, even when the interfering stations are on a different wave-length. This trouble may be very largely obviated by having an independent aerial circuit very loosely coupled to a receiving system oscillating at a frequency slightly different from that of the incoming signals. Sets using circuits similar to those of Fig. 5 may be adapted by having the aerial and earth connected to a simple outside circuit, instead of to the Fig. 5 circuit. Fig. 8 shows the arrangement, the aerial circuit being several feet away from the set. The aerial and earth terminals of Fig. 5 may be left open, shorted, or shunted by a fixed or variable condenser, each arrangement giving a different range of wave-lengths as desired. The aerial circuit is

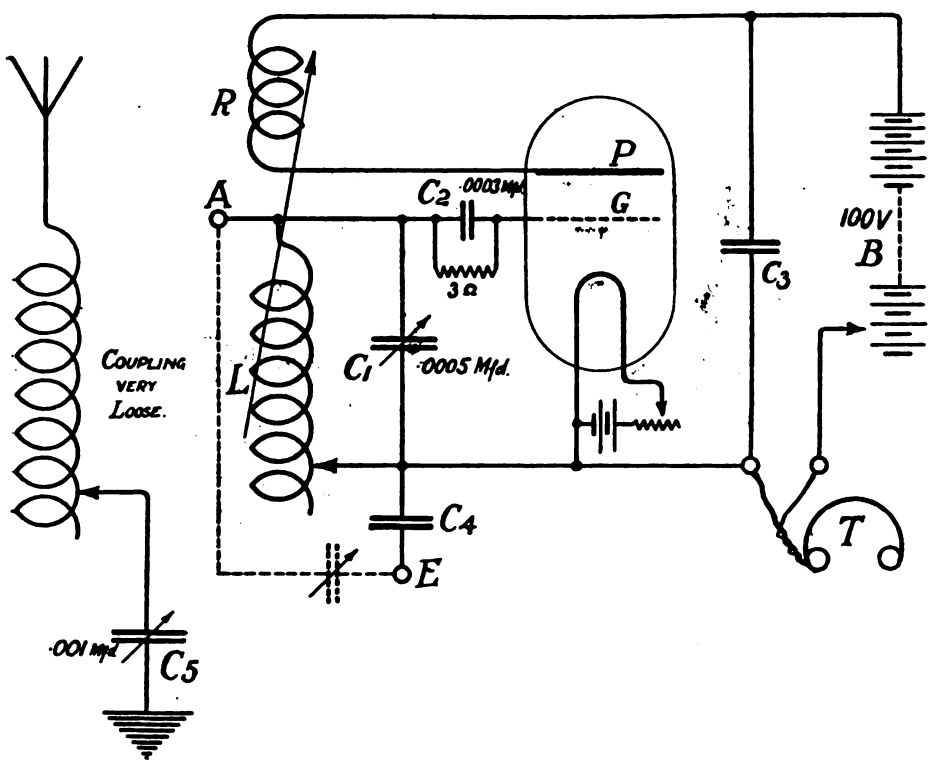

Fig. 8.

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tuned approximately to the incoming signals, and the operator adjusts his Fig. 8 circuit until the C.W. transmitting station is heard. The signals in the aerial circuit consist of forced oscillations, and therefore varying the tuning of that circuit does not alter the *pitch* of the note heard in the 'phones, but only the strength, which, of course, is greatest when the aerial circuit is in tune with the incoming waves. If desired, a simple aerial circuit may be arranged, and the operator may listen-in on his wave-meter; or the inductance and condenser of the Fig. 5 set may be used for the aerial circuit, the valve current being decreased, the operator listening-in on his wave-meter. In all cases the principle is the same. The continuous oscillations of the aerial circuit are capable of inducing across a greater distance than spark signals which practically die out on account of the very loose coupling. Spark interference may thus be cut down to a minimum or eliminated altogether. The strength of the continuous wave signals is also somewhat decreased, but not in the same proportion, and their strength can always be subsequently increased by low-frequency amplification.

Interesting experiments may be carried out by using a Fig. 5 circuit which is just *not* oscillating, the incoming signals being heterodyned from outside by means of an oscillating wave-meter placed near the set. Altogether, the subject affords ample opportunities for experimental and research work, and will undoubtedly play a very great part in wireless communication in the future.

Photo: Giles' Photo Agency.

The Crew of the Handley-Page Aeroplane which at Easter made the first successful flight round Great Britain. Wireless Operator Dymant is the figure on the extreme right (bottom row).

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Aircraft Wireless Section

Edited by J. J. Honan (late Lieutenant and Instructor, R.A.F.).

These articles are intended primarily to offer, as simply as possible, some useful information to those to whom wireless sets are but auxiliary "gadgets" in a wider sphere of activity. It is hoped, however, that they may also prove of interest to the wireless worker generally, as illustrating types of instruments that have been specially evolved to meet the specific needs of the Aviator.

AIRCRAFT WIRELESS SETS.

The Sterling Transmitter—(Continued.)

TUNING THE OPEN CIRCUIT.

IN the case of the open circuit the question of tuning is somewhat more involved. It is obvious that the aerial-earth capacity of the ordinary land aerial is here replaced by the capacity effect between the plane and the hanging aerial.

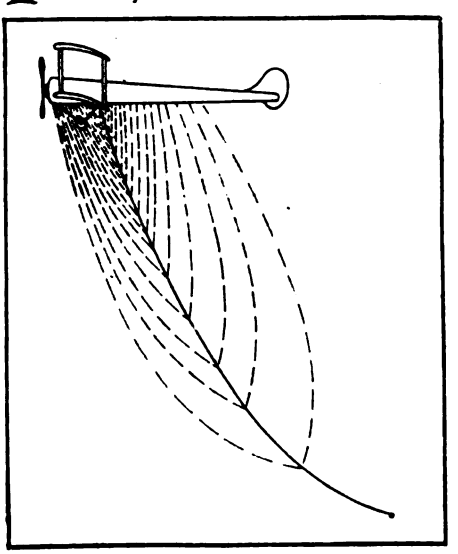

Fig. 5.

The distribution of the lines of static strain are shown approximately in Fig. 5. The concentration is greater close to the plane than it is further out towards the plummet of the aerial.

In consequence, equal increments in aerial length give diminishing increases of capacity value. Moreover, the total capacity of the circuit for any given length of aerial will vary with each type of plane. The earth lead of the set is connected to the engine and to any other metalwork available, such as petrol tank, wire stays, etc., and the capacity value of these is dependent upon their total weight, area, disposition, etc., factors that alter with different types of machines.

It is obvious therefore that the only satisfactory way of tuning the open circuit is by experiment whilst in the air with the particular machine in question.

In practice the set is placed in the bus after the *closed circuit* has first been adjusted to the required frequency by means of the tuning-clip. *The coupling should be loose*, say one turn of the helix.

The machine is then taken up and the aerial is let out—fairly rapidly at first—until a length approximating the correct value is approached. During this time the transmitting-key is operated at fairly frequent intervals and a watch is kept upon the readings given by the hot-wire ammeter.

A maximum reading will obviously be shown by the ammeter when the open circuit is accurately in tune with the

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closed circuit, for then, and then only, do the inductance and capacity of the open circuit counterbalance each other for the particular frequency to which the closed circuit has been set, thereby enabling the current in the former circuit to acquire its maximum value—limited only by natural or ohmic resistance. The ammeter readings should therefore increase with length of aerial until the correct length is in play to put the circuit in tune.

Beyond that point further increase in aerial length only results in a decreased ammeter reading. As the critical point is being approached the aerial should be let out more gradually and the ammeter readings carefully watched.

(It will be remembered that the coupling was, in the first place, set at "loose." The necessary adjustment that should now be made in order to increase this degree of coupling up to the most efficient radiation value is more fully described in the next paragraph. It does not affect the correct aerial length, as just determined, to any perceptible amount, but it is the next adjustment to be made in completing the calibration of the set.)

Once the exact length has been ascertained the aerial should be marked in any suitable way or adjusted permanently to that length for future use.

If the aerial is intended for use with more than one wavelength, a similar calibration must be carried out for each wavelength, after first adjusting the closed circuit to the new frequency by means of the tuning-clip. The aerial is then marked at the points so determined and can therefore in future use be rapidly dropped to the correct depth for the wavelength required.

The manner in which the aerial length varies with different wavelengths in the case of an R.E.8 machine is shown in the following graph:

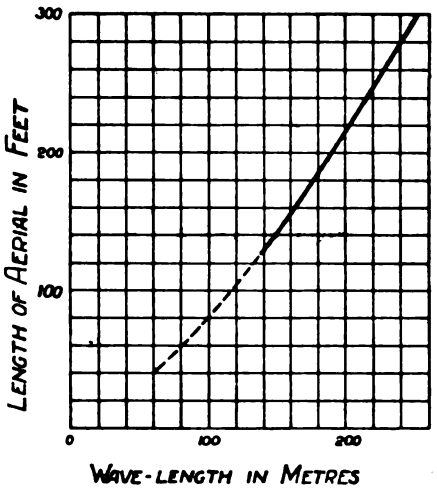

Fig. 6.

It may be of interest here to note that the value of the *inductance* of 180 feet of Service type of aerial (R4 seven-stranded spiral) is almost exactly 90 microhenries. Every additional foot measure beyond this length adds 0.8 microhenry to the total.

The inductance value of the calibrated helix is relatively small—approximately 11 mics.

As previously stated, the added capacity effect grows less and less for equal increments in the aerial length. Hence as the aerial is lengthened, the inductance of the open circuit increases at a greater rate than the capacity effect, a fact which adversely affects the "form factor" and the radiation decrement for the longer wavelengths.

COUPLING.

The final adjustment so far as the circuits are concerned is to determine the degree of coupling that gives maximum radiation of energy at the particular wavelength desired. As has already been pointed out the circuits are auto-coupled through the common part of the helix. The length of this common part and therefore the degree of coupling

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is fixed by the position of the coupling-clip.

This part that is common to the two circuits, is, of course, the channel through which energy is transferred from the closed to the outer circuit. Considered merely as a path of transfer, the greater the extent of coupling the more energy—of a kind—is passed.

But the circuits have both been tuned to a definite wavelength, say 200 metres, and the problem is to transfer the greatest possible amount of energy at this particular frequency.

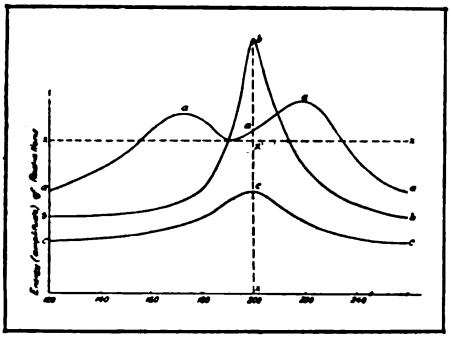

Fig. 7.

If too loose a coupling is used, but little energy gets through to the aerial and thence to the other. The curve *c*, Fig. 7, shows the effect that energy so radiated would have upon an infinitely-sensitive receiver tuned in succession to different frequencies. The maximum effect would be registered by the receiver when tuned to 200 metres, but the impulsive effect represented by the ordinate cX would be relatively small. The total energy (at all wavelengths) so radiated would be measured by the area of the curve.

On the other hand, the curve *a* represents the effect of too tight a coupling—or too wide a path of energy transfer.

It must be borne in mind that not only is the coupling a path for energy to flow from the closed to the open circuit, but it is also equally a channel whereby the open circuit reacts inductively upon the closed circuit. The greater the amount of energy transferred in one direction, the more violent is the inductive reaction that causes energy to be poured back from the open to the closed circuit through the coupling channel, and therefore to be wasted so far as radiation is concerned.

The result of such over-coupling as registered by the above receiving-device is shown by the curve *a* where aX is the value of the energy radiated at 200 metres wavelength.

The intermediate curve *b*, however, represents the ideal condition as obtained by correct coupling. The actual amount of energy radiated may not be so great as in the previous case, but the bulk of it is concentrated at or about a frequency corresponding to a 200-metre wavelength, and it will therefore react powerfully upon a receiver tuned to that wavelength.

In the case of a receiver not infinitely sensitive, but, as in actual practice, only responsive to ether vibrations having an amplitude above that represented by the dotted line xx, it is now obvious that when such an instrument is tuned accurately to 200 metres, energy, corresponding to the curve *c* will not be registered at all; that corresponding to curve *a* will only be faintly responded to, proportionately to the height aX^1; whereas energy radiated according to the curve *b* will have a pronounced effect corresponding to the height X^1b.

The last then corresponds to correct transmission giving a high degree of selectivity.

In practice—as opposed to theory—the adjustment of the coupling point is a simple matter and is ascertained immediately after the open circuit has first been tuned in the air. Whilst the correct aerial length for tuning is actually being determined, the coupling should be kept loose—not more than one turn.

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As soon as maximum ammeter reading has indicated that the open circuit is in tune, then the coupling should be gradually tightened by moving the coupling-clip inwards along the helix. This will give a slight further increase in ammeter reading up to the critical point of correct coupling. Any increase in coupling beyond this point will cause a fall in ammeter reading.

The additional inductance thrown into the open circuit by tightening the coupling is so small in comparison to the total inductance of that circuit as not to cause any significant de-tuning effect, so that no readjustment of the aerial length is necessary.

The correct degree of coupling varies with different wavelengths owing to the fact that the aerial length and therefore the inductance of the open circuit is altered with the wavelength to be transmitted, and consequently also the value of the reaction effects between the two circuits, of which the coupling factor is a function.

The results so determined in the air should be recorded, and a complete calibration test should show (a) what length of aerial to use; (b) the turns of coupling required, for (c) each particular wavelength to be transmitted. This information should be tabulated by the person responsible for fitting and testing the wireless installation of each plane, and a corresponding calibration card fixed up in some convenient site in that plane to serve for the guidance of wireless operators subsequently using the set.

As an example, the following table shows the relation between wavelengths, aerial lengths, and degree of coupling in the case of an R.E.8.

Photo: Topical Press Agency.

Wireless Apparatus for the Short Transatlantic Aeroplane.

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Wavelength (metres)	Aerial length (feet)	Coupling (turns)
140	131	1.25
160	160	1.50
180	185	1.50
200	212	1.50
220	245	1.75
240	285	1.75
250	300	2.00

POWER FACTORS.

It is difficult to give accurate figures representing the input and output of power in such a set as the Sterling. Some useful comparative information may, however, be obtained by a consideration of the approximate energy distribution throughout the circuits.

As measured by a direct-current ammeter, the normal current flowing in the primary circuit whilst the set is in operation is about 3 amps. This is, of course, not a reliable way of measuring the value of a periodically interrupted current, but it is a useful approximation. As the normal voltage is 6, these figures represent roughly an energy input of 18 watts.

In the secondary circuit we may for the present purpose assume a spark frequency of 250 per second, and a spark voltage of 5,000. Then as the condenser has a fixed capacity of .0025 mfds., the energy flow may be roughly reckoned as that due to a condenser discharge of 5,000 volts at the given frequency—

$$\text{i.e., energy in watts} = \tfrac{1}{2}\,KV^2 \times 250$$

$$= \tfrac{1}{2} \times \frac{\cdot 0025 \times 5000 \times 5000 \times 250}{10^7}$$

$$= 7{\cdot}81 \text{ watts.}$$

The proportion of this energy that is transferred through the auto-coupling to the open circuit is much more difficult to estimate.

If the whole of the energy were represented by undamped oscillations, then after an initial period of time practically all the energy from one circuit would be transferred to the other. But, actually, the high-frequency oscillations are damped, and heavily damped, so that a big proportion of the total energy of a wave train is carried by the first wave. The proportion of the energy of this first wave transferred from the closed to the open circuit will primarily depend upon the degree of coupling, so that within limits it may be taken that this factor mainly determines the energy transfer.

In actual practice, a loose coupling means a small proportion of energy transfer, and therefore a short range, whilst tight coupling secures a greater energy transfer, and consequently a longer range, considering only untuned radiations in both cases.

When, as is more usual, selectivity is a consideration, and it is desired to radiate at a definite wavelength, the effect of mutual interaction between the open and closed circuits, becomes important, and the coupling is adjusted, as previously described, so as to ensure a maximum radiation at the required wavelength, rather than a maximum energy radiation at all wavelengths.

(*To be continued.*)

WIRELESS TELEPHONIC CONTROL OF AIRCRAFT.

New Yorkers had the unique privilege of listening to wireless telephone conversations with a squadron of aeroplanes which soared over the city in battle formation each afternoon during the period of the Aeronautical Exposition, held from March 1st to March 15th. The squadron flights were controlled entirely by wireless telephones.

The novel feature was the privilege given to the general public to wear flying headgear and helmets during the period when formation flying was under way. Visitors were permitted to converse with the squadron commander and also listen to the orders given from the ground, and from the squadron commander to the rest of his pilots.—(*"The Wireless Age."*)

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Aviation Notes.

THE TRANSATLANTIC FLIGHT.

AS we go to press, expectation of an imminent start is still maintained from day to day. Messrs. Hawker and Raynham have for some time past only been waiting for a weather report that could reasonably be interpreted with the word "go."

Unfortunately the public generally have been kept at such a fever heat of anticipation by the newspapers that the prolonged delay has, by reaction, introduced an element of farce into the situation. This has not been lessened by the unfortunate experience of Major Wood, who was forced by engine trouble into the sea near Anglesey whilst on his way from Eastchurch to Limerick, whence he proposed to make the ocean flight westwards.

That incident, however, only serves to emphasize the wisdom of waiting for such weather conditions as at least offer a fair prospect of success, for even with this much in hand, the handicap, as Major Wood has demonstrated, is severe enough. Foolhardiness is sometimes favoured with luck, but success more surely attends him who tempers ardour with due precaution.

It is a pity, in one sense, that public interest has been so long and continuously stimulated by day-to-day reports of an immediate start, whilst in fact, owing to the very unfavourable period of the year, the probability was very much against any prospect of a reasonable attempt until the weather became more stable with the advance of summer. However, that time is now approaching, and there is every probability that in our next issue we may be able to congratulate the victor, and perhaps one or more acolytes.

THE BOULTON-PAUL MACHINE.

Messrs. Boulton and Paul, of Norwich, have entered the list of competitors for the £10,000 prize. The machine is a special adaptation of their long-distance bomber. She has a cruising range of 3,800 miles, and is fitted with two 450 h.p. Napier Aero engines.

The firm are making a special feature of "safety first." The machine will fly fully loaded on one engine only; though under full power her maximum speed is no less than 148 miles per hour, with a normal cruising speed of 116.

She will carry three pilots, two being navigating and wireless experts. Two wireless installations are fitted—one a "spark" set for transmitting and receiving, the other a directional outfit for navigating purposes.

The flight will not be made before June or July. It is, however, intended to make the flight whether or not the cash prize has previously been won, the point of view being that the prize is only an auxiliary consideration to the more important point of demonstrating the future commercial possibilities of the right type of machine.

OFFICIAL WIRELESS CALLS FOR THE OCEAN FLIGHT.

For the information of all concerned, the Air Ministry has issued the following announcement:—

"Some confusion appears to exist

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with regard to the wireless call signs allotted to aircraft for the Trans-atlantic flight.

Each machine is given a group of three letters lying within the limits DKA to DMZ, which serve as a call sign, and as a rapid method of establishing the machine's identity.

Thus DKA is the wireless call sign of the competing Sopwith machine.

A further official announcement states that it has been provisionally agreed upon by the Aerial Sub Committee of the Peace Conference that the International signal, S.O.S., either by means of wireless or visual telegraphy, shall be the recognised urgent appeal signal for Aircraft in distress.

WAR WIRELESS.

Whatever may have been the case in the early days of the war, there is no doubt that latterly our whole wireless organization was much in advance of the Germans. The work of one Section of our Intelligence Department was to decipher each new code as it was evolved by the enemy. It was a fascinating business, and despite the utmost ingenuity of the Hun it seldom took more than a few days for our experts to pick his brains and unravel his weirdest cryptograms.

In the course of time, also, our operators became so familiar with certain of the enemy senders' characteristics that in many cases they could distinguish a particular transmitter even when he had been transferred from one station or plane to another.

An instance of wireless strategy occurred in connection with a big British counter-offensive in the Amiens sector. A big demonstration was arranged elsewhere, to which certain of our advanced wireless stations were despatched, with instructions to flood the air with bogus messages. This created such a vertical breeze that enemy reinforcements were immediately rushed to that quarter and away from the spot where they were afterwards badly wanted.

THE ANDOVER DISASTER.

Easter was marred by the news of the tragic accident to a Handley-Page Service machine at Weyhill Aerodrome, near Andover, in which, out of a crew of seven, five were killed and two injured. The machine was specially detailed for wireless work, and was about to start on a circular tour of Great Britain, a particular object of the trip being the testing of the efficiency of the wireless direction-finding installation.

According to the evidence of Lieutenant A. E. Greenwood, R.A.F. (Wireless), the machine started to "take off" at 2.20 a.m. About three-quarters of the way along the flare line her tail lifted, and shortly afterwards she left the ground. Almost immediately she appeared to bear slightly to the right, and following that two slight crashes were heard, succeeded by a louder crash. At the scene of the last crash the machine was found piled up against the wall of a hut and blazing furiously. Lying on the ground about twenty yards away, his clothes in a blaze, the rescue party discovered Lieutenant Westall, R.A.F., the Navigating Officer, one of the two survivors.

The remaining survivor, Flight-Sergeant H. W. Smith, told how, when the crash came, he found himself so entangled in the telephone leads that, but for the presence of mind of Lieutenant Westall in releasing him from the wireless receiver head-gear, he would have been unable to escape from the blazing wreck.

The machine carried 400 gallons of petrol. In the crash the tank burst, causing so fierce a blaze that it was im-

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Photo Photo Giles' Agency.

Wireless Telephony apparatus on flying boat. Note the headgear worn by pilot.

possible to approach the wreck for some time. It was, however, the positive opinion of Captain Bannerman, the medical officer, after an examination of the bodies, that death must have taken place in each instance, before the machine burst into flames.

The pilot, Major Batchelor, R.A.F., was one of the victims. Captain Gilroy in his evidence, stated that Major Batchelor was an extraordinarily careful pilot, and had considerable experience in flying Handley-Page machines. He was noted for his care in not climbing a machine too steeply, and possibly this very precaution, combined with the darkness, resulted in an error of judgment which led to the fatal result.

WIRELESS TELEPHONY BOGIES.

One can, it seems, have too much of a good time, and the development of the wireless telephone is beginning to cause a little anxiety as to where precisely its possibilities stop.

One writer deplores it as adding another horror to life. His dream of a peaceful week-end by plane to the South Sea Islands, to "some solitude where none intrude," is shattered by the threatened prospect of being rung up by his wife, with some long tale of woe, detailing how and why the new cook has given notice.

Another contemplates with satisfaction the joyful prospect of the crop of slander actions that will arise from indiscriminate tuning-in on other folks' conversation. Candour will be an expensive luxury!

However, we haven't reached that stage yet. There is still time for the coming generation to adapt themselves to the new complexities of life. We have just had a war, and it is only right that they should have their share of trouble too!

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The Library Table

"YEAR BOOK OF WIRELESS TELEGRAPHY AND TELEPHONY, 1919."

London: The Wireless Press, Limited, 7s. 6d. net. (7th Edition).

THE appearance of the seventh edition of the "Year Book of Wireless Telegraphy and Telephony" serves to emphasize the great extension of wireless working that has taken place under the strenuous conditions of a world-wide war. The whole of the information on recent wireless development is not yet available for publication, and in view of the large masses of data that have to be handled such publication must necessarily be slow.

The summary of the 1918 progress in the development of new apparatus and in high power and long distance wireless working is given in this volume, in a handy and useful form, while the extensive recent alterations to the Laws and Regulations relating to wireless working in various countries has brought this section of the Year Book up to no less than 475 pages.

Amongst other alterations a useful new feature has been added to the calendars in the form of a list giving particulars of the official holidays in the various countries of the world. The valuable section on land and ship stations and particulars of call signals has been overhauled and brought up-to-date as far as the current information allows. This section should also be of particular use to the wireless amateur and experimenter as soon as the present restrictions are relaxed, especially in view of the large increase in receiving ranges consequent upon the modern development of the valve amplifiers. Dr. J. A. Fleming has once again contributed with a valuable discussion upon "Maxwell's Electromagnetic Theory of Light and Its Important Relation to Wireless Signalling." The intimate connection between radiotelegraphy and aircraft is emphasised by an interesting article by Dr. W. H. Eccles dealing with the special maps for which the rapid progress of wireless and aeronautics is creating a demand. The uses of wireless telephony on aircraft are also dealt with amongst other matters in "A Review of the Methods and Progress of Radiotelephony" which is contributed by Mr. Philip R. Coursey. An instructive communication dealing with the "Experimental and Acoustic Characteristics of Telephone Receivers," by Dr. Louis V. King, has also a bearing upon the same thing.

Mr. I. Schoenberg's series of analytical notes and "Valve Patents in 1918" is likely to prove of great utility to experimenters in this field and forms an instructive addition to the similar series published last year, as does also the list of patent applications dealing with wireless, made during 1918.

A mention of the section on International Times and Weather Signals must not be omitted, especially on account of its great importance in connection with long distance aircraft flights. The map of the wireless stations of the world has again been brought up-to-date and now includes some 900 stations.

The Bibliographical notes have been revised and augmented, as have also the Definitions and the Five Language Dictionary of Technical Terms used in Wireless.

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Personal Notes

WIRELESS OPERATOR RECEIVES MILITARY MEDAL.

Mr. Montague V. Pocock (formerly 9176, 1st Air Mechanic) of Cardiff, has been decorated with the Military Medal for "conspicuous gallantry and devotion to duty." It seems that on June 25th, 1917, whilst working in conjunction with an aeroplane which was observing for a siege battery, Mr. Pocock's aerial was broken up by shell-fire. He mended the aerial under heavy fire and "carried on" after only a short interruption to the "shoot."

NEW APPOINTMENTS.

We learn that Captain W. A. Andrews, B.Sc., has been appointed lecturer in wireless to the Marine Technical School which is to be established at Cardiff Technical College.

Mr. H. E. Penrose, formerly the Chief Instructor in the School of Wireless Telegraphy at Marconi House, has been appointed by the Marconi International Marine Communication Co., Ltd., as their Resident Inspector at Capetown. Before his departure from this country Mr. Penrose received an illuminated address and a gift of silver from his colleagues in the School, with whom, as with all who know him, he was exceedingly popular.

Mr. H. E. Watterson has been appointed Wireless Telegraph Engineer to the Egyptian Government. This gentleman entered the service of the Marconi Company as an operator in 1903, and was eventually transferred to the engineering staff, doing duty connected with the erection and running of wireless telegraph stations in many parts of the world. During the war he held a commission in the R.N.V.R.

OXFORD HONOURS GENERAL FERRIÉ.

On May 6th, the University of Oxford conferred on General Gustave Auguste Ferrié, Technical Director of Military Wireless Telegraphy in the War Office at Paris, the degree of Doctor of Science *honoris causâ*.

OBITUARY NOTICE.

It is with deep regret that we have to record the death, on Friday, 9th May, of Mr. Henry Spearman Saunders, who was a director of the Associated Marconi Companies. Born in 1841, the deceased gentleman was the son of the Hon. Frederick Saunders, Treasurer of Ceylon. At an early age Mr. Saunders joined his parents in that colony, where he devoted himself to public and commercial life. On returning to England some eighteen years ago, Mr. Saunders accepted a seat on the Board of Marconi's Wireless Telegraph Company; later, he became a director of the Marconi International Marine Communication Company.

By his death, the Marconi Companies have sustained a severe loss.

HEROIC OPERATOR ON MIDLAND RAILWAY STEAMER.

Amongst other names that of Mr. A. Cowler, wireless operator on the s.s. *Donegal*, has been mentioned for valuable services performed when that vessel was sunk by enemy action on April 17th, 1917. Mr. Cowler, who lost his life on that occasion, was partly instrumental in saving the lives of some 700 wounded soldiers who were on board.

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The Construction of Amateur Wireless Apparatus

This series of Articles, the first of which was published in our April number, is designed to give practical instruction in the manufacture of amateur installations and apparatus. In the following article the author deals with the important question of Condensers. The Wireless Press, Ltd., has arranged with Marconi's Wireless Telegraph Co., Ltd., to supply complete apparatus to the designs here given, as soon as Amateur restrictions are released.

Article Three.—CONDENSERS.

IN the last article we pointed out the value of paraffined cardboard as an insulating material for the construction of apparatus. It must not be forgotten that it is only suitable for use in cool places and consequently it is not advisable to wind on cardboard formers coils in which an appreciable amount of heat may be developed. It is particularly valuable for the construction of inexpensive receiving apparatus.

Dielectric of Condensers.

(a) *Fixed Condensers.* The nature of the dielectric of a fixed condenser is governed by

(1) Potential to which condenser will be charged.

(2) Grade of insulation resistance required.

(3) Capacity of complete condenser.

Thus before any particular type of condenser is constructed thought should be given to the suitability of the contemplated design to the purpose in view. For the primary condenser of a spark transmitter a high insulation resistance is required, combined with great dielectric strength, but the total capacity required is in general small. These conditions are fulfilled by the employment of glass as dielectric. The plates of the condenser being formed by sheets of thick zinc or copper interleaved with the glass plates. Such a condenser is best totally immersed in dry vaseline oil. The oil keeps moisture from the plates and increases both the dielectric strength and capacity of the condenser. A sketch of such a transmitting condenser is shewn in Fig. 1.

For general use and for portable stations the best form is that shewn in Fig. 2. It consists of a glass tube, closed at one end, something like a large test tube. The tube is copper-plated both inside and outside to within a few inches of the open end. This copper-plating on glass is done by a special process, which gives a strong and durable coating in the closest possible contact with the surface of the glass. These condenser tubes are made of standard capacities, so that by connecting a number of them in parallel or series transmitting condensers of any desired capacity can be made up. Individual capacities of from 0.0006 to 0.001 mfd. are obtainable. Each tube will take a power of about 100 watts. It must be borne in mind that the power for which a primary condenser may be

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used is dependent upon the total volume of dielectric employed. This will be

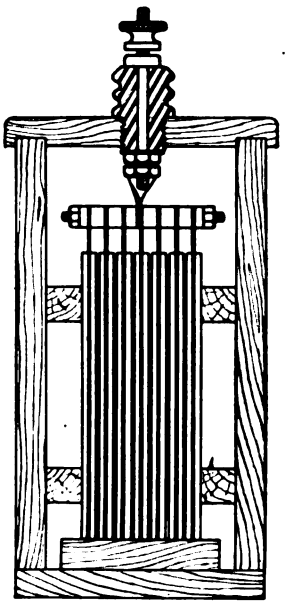

Fig. 1.

clear from a consideration of a numerical example. Suppose that we have one cubic inch of dielectric; this may be made up, for example, either as a condenser with plates 1″ square separated 1″, as shewn at (a) Fig. 3; or, on the other hand, it may be employed as at (b) Fig. 3, in which case the plates are 2″ square and the dielectric is $\frac{1}{4}$″ thick. Now, in case (a) let the maximum permissible voltage we may apply to the plates be V, and let the capacity of the condenser be C. Then the energy E_1 stored is given by

$$E_1 = \tfrac{1}{2}CV^2 \quad \ldots\ldots (1.)$$

In case (b) the dielectric is only $\frac{1}{4}$″ in thickness and therefore we may apply one quarter of the voltage allowable in case (a). But since the plates of the condenser are only separated by one quarter of the distance of the plates in (a), the capacity *per square inch of plate* is four times as great as before. And as the plates are now four square inches each in area, instead of one square inch, the capacity of (b) condenser is sixteen times as great as (a). The energy E_2 which can be stored in this new condenser is therefore given by

$$E_2 = \tfrac{1}{2} \times 16C \times \left(\frac{V}{4}\right)^2$$
$$= \tfrac{1}{2}CV^2 \quad \ldots\ldots (2)$$
$$\therefore E_2 = E_1.$$

And since the volume of dielectric in the two cases is the same, we obtain the important result that the energy which can be stored in any condenser is simply proportional to the volume of the dielectric, and is independent of the size of the plates and the thickness of the glass or other insulator. It might appear from this that the power which may be put into any given condenser will be directly proportional to the spark fre-

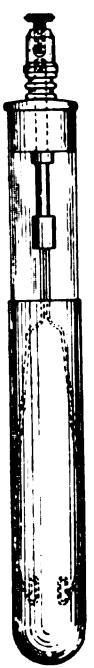

Fig. 2.

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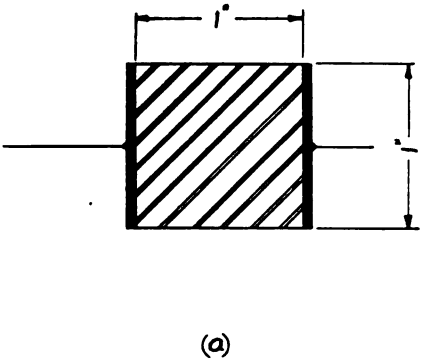
quency. It is found, however, that in practice an increase of spark frequency must be accompanied by a decrease of potential to which the condenser may



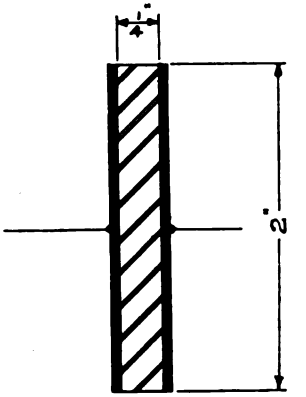


Fig. 3

be charged before the spark occurs. This is due to the fact that the ultimate strength of the condenser is dependent upon the temperature of the dielectric. Now when an oscillatory current is flowing through the condenser there are losses in the glass or other dielectric employed. These losses appear in the form of a rise of temperature of the dielectric. The temperature rise which is allowable for any given insulation strength will limit the power which can be dealt with by the condenser. For this reason it is usual to specify small condensers by the maximum power they may be used for. As before mentioned, the copper-plated tubes are suitable for about 100 watts each.

(b) *Variable Condensers.* Undoubtedly the best type of adjustable capacity for receiving work (and low power C.W. valve transmitters) is the "air condenser." This pattern is made in various forms, but always consists of a number of fixed plates or vanes between which a similar series of plates are arranged to move. The insulation between the plates is provided simply by the air gap between them. This type of condenser is the most efficient in existence. The insulation resistance is practically infinity and there is no dielectric loss. When designing an air condenser care should be taken to maintain insulation of a very high order between the leads connecting the plates to the terminals of the condenser. Any resistance in the connections will nullify the advantage obtained by the use of air dielectric.

The chief disadvantage of the air condenser lies in the fact that it is bulky and costly for a given capacity. By the use of ebonite sheets in between the plates as dielectric, the size and cost of the complete condenser can be very much reduced. The ebonite generally used is very thin. It is specially selected and is ground down to a definite thickness. This material is a commercial article. Its use is recommended, as condensers with ebonite insulation are more easily constructed by the amateur; the plates can be got much closer together without the danger of shorting, which exists in the case of the air condenser. Detailed designs for variable condensers will be given at a later date.

One of the most difficult points in the construction of a variable condenser is the connection from one terminal of the instrument to the moving

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vanes or plates. Quite a good method is that of a rubbing contact, secured by a brush pressing on a slip ring or collar on the spindle of the moving plates. When this type of contact is used, it is necessary that the ring should be in an accessible position in order that the contact surface may easily be cleaned when required. The construction is employed on many condensers manufactured by the Marconi Company, and will be familiar to amateurs acquainted with the "Multiple Tuner." Another method of securing contact is to use flexible leads. This has the advantage of the most certain contact, *as long as the lead is intact.* But condensers which are in continual use are liable to faults owing to breaks in the connecting leads. Great care should be taken in soldering any flexible leads which are subject to repeated bending. In any case only resin should be used as a flux, as corrosion is certain to set in close to the soldered point if any chemical soldering compound is used. Another form of contact to the moving member consists of a gold wire making an arc of contact on a grooved pulley. The wire is kept in light tension by means of a small spring. Fig. 4 illustrates this method. Owing to the movements of the pulley the groove rapidly becomes plated with gold and good contact is thereby ensured. It is most important that the contact should not be microphonic in character. It is just as important that contacts in the oscillatory circuits of a receiver should be as perfect as in the batteries or telephone circuits. Bad contacts on the moving parts of a condenser will cause scraping noises in the telephones whenever an adjustment is made. It is not safe to rely simply on the contact between the spindle supporting the moving plates and the bush in which it moves. Grit and dirt will always collect in the part, and eventually result in inferior conductivity. If it is necessary to use this method some form

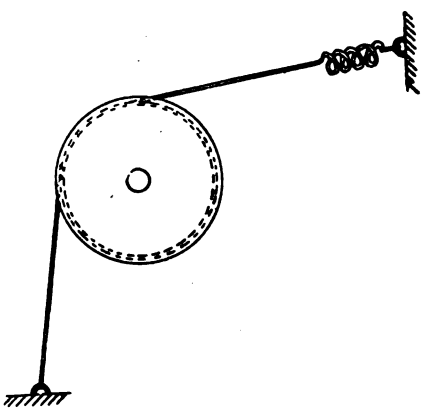

Fig. 4.

of spring washer should be inserted between a collar on the shaft and the bearing bush. In the case of copper on brass, or brass on brass contacts, the conductivity is improved by the presence of a little vaseline on the rubbing surfaces. The action of the vaseline is uncertain. One would imagine that the presence of a film of insulating oil between the metal surfaces would raise the contact resistance. As a matter of fact, the measured resistance of a lubricated contact is considerably less than the same contact when worked dry. Of course the vaseline is not to be used on the gold wire contact just described.

In general, the amateur may safely use the flexible lead connection in cases where the condenser will only be adjusted occasionally. Where constant movement takes place the rubbing type of contact should be chosen. It should also be noted that the system shown in Fig. 4 allows the moving plates to be rotated continuously in either direction.

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Jones, on the other hand, probably does not work so hard as Smith—but there is *quality* in his work. At every turn he displays those abilities which single a man out in the eyes of his employer. Jones's memory is good; he is quick to observe and to comprehend; he does not hesitate to act without orders in emergency; he is resourceful, has ideas, and is not afraid to bring them forward. His attitude is one of alertness and self-reliance, and he does not have to ask for advancement; his qualities make progress both rapid and certain. The fact is, employers do not promote men capriciously; they cannot afford to. Brain power is too valuable in business to be passed over. Every employer wants the best brains he can get, and is only too glad to attract and keep them by paying good salaries. That rule is invariable. And the Pelmanist manifests his efficiency so plainly in action, speech and personality that, whether the employer is aware of the training or not, he recognises the *result*, and appreciates it,

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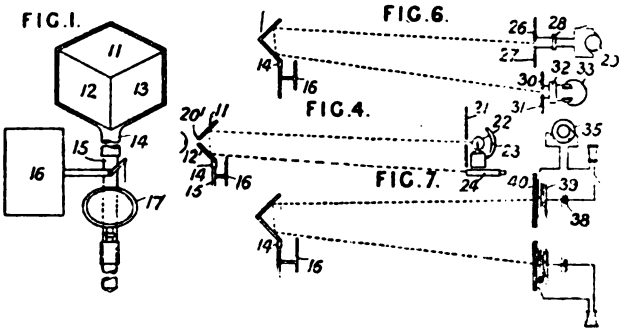
Patent Section

Under this heading will be printed each month abridgments from the Illustrated Official Journal (Patents) of wireless patents recently published.

122,418. Signalling, etc., reflectors. Fessenden, R.A., 1677, Beacon Street, Brookline, Massachusetts, U.S.A. January 14th, 1910. No. 1012. Convention date, January 14th, 1918. Not yet accepted. Abridged as open to inspection under Section 91 of the Act (Classes 13, 40 (v), 97 (i), and 118 (ii)).

Signalling is carried out by employing a reflector formed of three surfaces each at right angles to the other two which is used to reflect waves of light, sound, electricity, etc., back to the place of origin independently of the position of the mirror, provided that the waves to be reflected enter the solid angle between the three surfaces. The invention is described in connection with signalling from advanced positions to bases during an attack from aeroplanes or for locating the position of buoys, and in connection with wireless telegraphy, and means for producing and detecting sound waves of a frequency above the limit of audibility. As shown in Figs. 1 and 4, applied to an optical signalling system between an advanced position and a base, etc., the forward operator is provided with a reflector 14 formed of three surfaces 11, 12, 13 which are plane mirrors which may be formed with a hole 20^1, at the point of intersection. The reflector 14 is mounted on a rod 15 to which is fitted a shutter 16 which may be employed to send messages back to the rear position at which the transmitting lamp 22, reflector 23, and shutter 21 are situated. A telescope 24 is employed, and when this is directed towards the reflector 14, the reflected light is seen. The shutters 21, 16 can then be used to transmit messages. The forward operator carries the reflecting device only, and is thus not impeded. A mirror 17 may be mounted on the rod 15 and the device is then usable as a periscope in conjunction with the mirror 11. The shutter 16 can be worked from a trench without exposing the operator. The mirror may be formed of a glass tetrahedron with three silvered reflecting surfaces, the base being formed of plane glass, and if desired a small part of the glass at the intersecting corner is ground away to serve the same function as the opening 20^1, Fig. 4. Ultra-violet rays may be used for night signalling, and detectors such as fluorescent screens of quinine sulphate may be used at the position 20^1, or at the object glass of the telescope. A number of reflectors as 14 may be attached to a buoy, and by means of a searchlight it may be picked up by an observer on a ship without mistaking a shore light for a buoy light, and without indicating to an enemy the position of the buoy. As applied to wireless telegraphy the waves produced by conductors 26, 27, Fig. 6, are audion or pliotron 28, and a source of electric power 29, are reflected by a mirror 14 and a metal shutter 16 can interrupt the reflected waves before they reach a receiving device comprising conductors 30, 31, receiver 32, and a double telephonic head receiver 33. For utilizing sound waves of high frequency, these may be produced by a diaphragm 40 operated by transmitting high frequency alternations through a condenser system 39, and in some cases through a telephonic transmitter. The receiving apparatus is similar to the transmitter, and a shutter 16 is used to send the signals from the trench position. The high frequency alternations are produced by a pliotron generator or a high frequency dynamo of the kind described in U.S. Patent 706,737. The sound waves may be produced as described in U.S. Patent 1,167,366.



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Questions and Answers

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless telegraphy. Readers should comply with the following rules:* (1) *Questions should be numbered and written on one side of the paper only, and should not exceed four in number.* (2) *Queries should be clear and concise.* (3) *Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before.* (4) *The Editor cannot undertake to reply to queries by post.* (5) *All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or if so desired, under a "nom-de-plume."* (6) *Will readers please note that as amateurs they may not at present buy, construct or use apparatus for wireless telegraphy or telephony.* (7) *Readers desirous of knowing the conditions of service, etc., for wireless operators, will save time by writing direct to the various firms employing operators.*

"CURIOUS" (London) E14.—Has experienced one of those static phenomena which are very difficult to explain. We will give a precis of his letter for the benefit of our readers:—

> "About June 15th, 1918, I was serving in a ship in the neighbourhood of Portland Bill. About 2 p.m. a humming was heard in the telephones which increased in strength. The receiving set was switched off and it was noticed that the transmitter connections were humming. Also a continuous stream of sparks occurred at the earth arrester. The sound emitted from the silence chamber when the door was opened was almost unbearable, and when the cabin was darkened brushing was observed at the Bradfield connection and the sockets of the A.T.I. The demonstration lasted about 25 minutes. The weather was quite clear and there were practically no X's."

It is possible that the effect was caused by a powerful station in the vicinity of the ship. The fact that the effect was continuous and with no semblance to the Morse code could be caused by the "holding down" of the transmitting key. Possibly the ship's set was in tune with the wavelength of the transmitting station, which would induce comparatively large currents to flow in the ship set. We have come across instances of aerials, close to a powerful transmitting station, being in tune with the wavelength of that station. In one case the primary of a magnetic detector was "burnt out," and in the other a spark gap was inserted in the lower end of the aerial when sparks occurred across a gap of about 1½ inches and fused the two nails forming the gap. We have not, however, come across a case where the effect produced was as powerful as seems to have appeared in the instance reported. If any of our readers were in the neighbourhood at this time and came across any like effect we should be pleased to have their experience.

"THANK YOU" (Bolton).—Wishes to know (1) Why when the magnets of a magnetic detector are placed with their like poles together "hissing" is heard in the telephones, but not when unlike poles of the magnets are placed together?

The hissing heard in the telephones, or "breathing" as it is technically known, is due to a peculiar hysteresis of the iron forming the band, which does not occur when unlike poles are placed together. Some operators prefer to arrange the magnets so that the breathing is eliminated, but the result is a certain amount of decreased sensitiveness.

(2) How is it that in the D.C. Side of a 1½K.W. rotary converter the instruments indicate a current of 15 amps. at 100 volts, when on the A.C. side the instruments indicate 25 amps. at 75 volts a seeming increase of power?

Our correspondent evidently does not realise the fact that the instruments in the A.C. side of the converter do not indicate the power in that circuit. This circuit contains a certain amount of self inductance, and when an alternating current circuit contains self inductance the product obtained by multiplying the volts and amperes is greater than the actual power in the circuit. The product $C \times V$ is known as the "apparent" watts and this product must be multiplied by a fraction known as the "power factor" in order to obtain the power or "true" watts in the circuit.

The power factor of a circuit is the cosine of the angle of lag, which angle is determined by the amount of inductance in the circuit. Hence we get that the power in an alternating current circuit

$$= C_V \times E_V \cos. \theta$$

where $C_V \times E_V$ is the virtual value of the current and voltage and $\cos \theta$ the cosine of angle of lag.

(3) If the speed of a 1½K.W. rotary converter is increased would the power also be increased?

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Speeding up the converter increases the spark frequency, but this may result in either an increase or decrease of the radiated power. There is with every set a speed which is the most efficient and it all depends on whether the alteration in speed becomes nearer to or further from the critical speed as to whether more or less power is radiated.

"Thank You," in the fourth question, states that inductance depends on the ampere-turns and the rate of change (*i.e.*, frequency) and that if the frequency is increased the inductance is increased, whereas in a high frequency circuit the wavelength is increased by increasing the inductance but the frequency is decreased.

The whole of our friend's trouble arises from the fact that he is confusing "rate of change" of current, with the frequency or rate of alternation of the current. The frequency of the current in any alternating current circuit is a constant value for that circuit, and depends on the frequency of the supply, but the "rate of change" of current is a varying quantity and is a maximum when the current is at zero and decreases to a minimum when the current is a maximum. The inductance of an air core inductance coil depends on its geometrical form, but for an iron-cored coil it depends on the physical properties of the core as well as the dimensions of the coil. The magnetic state of the iron varies somewhat with the frequency of the current, but for all practical purposes it can be taken that the inductance of a coil is independent of the frequency.

G.B. (Plymouth).—Desires to know what should be the dimensions of a coil, and the size of wire with which it should be wound, to tune an aerial 50 feet long to a wavelength of 2,500 metres?

Answer.—For the benefit of those readers who may take up the study of wireless in the near future, we will deal with this question fully in the hope that new investigators may themselves make these necessary calculations. In the question under consideration we will assume that the aerial is a vertical straight wire 50 feet long.

Now the natural wavelength of an ordinary vertical aerial is roughly equal to four times its length, so that the natural wavelength of a single wire aerial 50 feet long is 200 feet, or 60 metres. The wavelength it is desired to receive is 2,500 metres, the ratio therefore being,

$$\frac{2,500}{60} = 41$$

The capacity of an aerial depends on the diameter of the wire, and also on its situation with respect to the earth. As we have assumed our aerial to be a straight vertical wire the earth effect may be neglected when making rough calculations.

Let the diameter of the wire be 1 mm., then for a wire 15 metres long the ratio

$$\frac{L}{\frac{d}{2}} = \frac{15,000}{\frac{1}{2}} = 30,000 .$$

By referring to Prof. Howe's article reprinted in W. H. Nottage's Calculation of Inductance and Capacity, page 126, we can find, on reference to Table 5, that taking the ratio

$$\frac{L}{\frac{d}{2}} = 30,000$$

gives an average potential for our aerial of 20v. The capacity is equal to

$$\frac{\text{Total charge on aerial}}{\text{average potential}} = \frac{1,500}{20} = 75 \text{ e s u}$$

$$= 83 \text{ micro-microfarads.}$$

We can assume that the aerial may be treated as a concentrated capacity without inductance—since the latter is negligible compared to that of the tuning coil required—so that the formula λ m $= 1885 \sqrt{L.C.}$ can be used.

Hence

$$2,500 = 1,885 \sqrt{0.000083 \times L}$$
$$L = 20,000 \text{ mhy.}$$

This will be somewhat too large, since a coil of this inductance will have of itself an appreciable capacity comparable to that of the aerial, which has been neglected.

A coil which would have an inductance of 20,000 mhy. can be made by winding 520 turns of No. 26 s.w.g., s.s.c. wire on a former 16 cms. in diameter, and 28 cms. long. We will leave "G.B." to work out the length of wire required. If the former is made of cardboard tube the tube should be coated with shellac varnish before winding and the winding should then be shellaced. It will be necessary in order to make contact with the turns to bare a strip along the coil about ¼-in. wide and to use a sliding contact. Our correspondent should have no difficulty in picking up the more distant stations whose wavelength is within that of his own set, provided he uses his detector, etc., to the best advantage.

BRONDESBURY (Brondesbury).—(1) The school to which you refer no longer exists. This reply disposes of your second question.

E.E.H. (Stratford, E.).—For reception by ear, 25 words a minute is about the average speed. Naturally, the speed of working depends upon the amount of "jamming" present and the strength of signals, apart from the operator's skill. As regards the speed of transmission, this is obviously regulated by the speed at which the receiving operator can receive. We do not know the highest speed an expert *can* attain, but we have known men to receive and write down legibly at 48 words per minute, and transmit by hand at about the

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same speed. If the message is not to be written down, receiving speed may be as high as 60 words per minute.

D.J.M.C. (Edinburgh).—Quite impossible to answer your question, because the matter in question is regulated by a fixed scale based on length of service, and grade. Why not apply direct to the company you mention?

J.C.R. (Bournemouth).—Certainly, provided you do not without permission (at the present time) obtain apparatus for W/T or divulge information which is at present the secret of any Government authority. Applications for permission to purchase and use W/T apparatus must be addressed to the Secretary, G.P.O., London.

S.B.M. (Glasgow).—It is possible for you to obtain an appointment as a Marconi operator and join a ship without coming to London, but you would have to communicate with the London office of the Marconi Company.

H.W.C. (Leith).—(1) Your navy experience may not have included what is very necessary, viz., a knowledge of commercial wireless sets (Marconi system), and a knowledge of the extensive rules regulating commercial wireless traffic. A short course should, however, be sufficient. (2) In C.W. there is no break between each cycle. This question discloses your need of further study.

W.L.B. (Ealing).—In a discussion on Ohm's Law and carborundum crystals, W.L.B. maintained that Ohm's Law is not interfered with in the case of a crystal; he deduces that the variation of effective resistance due to Joulean heating and Peltier effect will explain the shape of the current-voltage curve, without interfering with Ohm's Law.

From this he arrives at the conclusion that no known substance obeys Ohm's Law, since all substances vary their resistance with heat—"with the possible exception of manganin at normal temperature."

Answer.—In the first place W.L.B. is not quite clear about the definition of Ohm's Law, which states that "In any conductor at *uniform temperature* the current is directly proportional to the P.D. between its ends."

This means that as long as the conductor remains at a constant temperature, the curve connecting the current and the voltage will be a straight line. If the temperature of the conductor is raised, and maintained at that temperature, the current-voltage curve will still be a straight line, and will always be a straight line no matter what the temperature of the conductor, providing it is kept constant during the time the readings of current and voltage are taken. The temperature co-efficient curve which W.L.B. is confusing with the Ohm's Law curve is obtained by noting the current due to a known voltage when the conductor is at different temperatures.

We have placed a part of W.L.B.'s statement in inverted commas, as this somewhat defeats his argument since he includes the words at "normal temperature." The temperature co-efficient curve of manganin is a straight line because its resistance does not increase with temperature.

Now the exact action of a carborundum crystal is not yet understood, but it is well known that even when great care is taken to keep the temperature of the crystal constant, the voltage current curve has a rising characteristic shape, and since the current flowing is not proportional to the applied voltage, it is quite true to say that a crystal does not follow Ohm's Law.

The metals mostly have a positive temperature co-efficient, that is, an increase of resistance with increase of temperature, but carbon and most non-metals have a negative co-efficient, that is, the resistance decreases with an increase of temperature.

R.E.T. (Scotland).—We regret to hear that you have been forced to leave the Service owing to ill health, and hope that when the restrictions on amateur working are raised you will be an enthusiastic worker.

With regard to the fact that a small spark can be obtained by allowing newly ground oatmeal to fall on to an iron plate, this is due to the particles of oatmeal becoming electrified by friction during grinding. When standing on a presumably insulated iron plate the charge is stored until discharged by connecting to earth. The spark would resemble an oscillatory spark owing to the capacity of the oatmeal and body.

(2) It is quite impossible to give any idea of the price of fitting up a receiving set as everything depends on the range of the set, and the ability and facilities for making one's own apparatus.

SHARE MARKET REPORT.

The shares of the Marconi group have shown considerable activity during the past month, owing to recent developments in Wireless and to the fact that the whole system is working.

The announcement of the new issue of Shares in the Marconi International Marine Communication Company was very favourably received, and the Shares show a marked advance in price.

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THE
WIRELESS WORLD

No. 76
Vol. VII

JULY
1919

"W/T. R.E."

An Account of the Work and Development of Field Wireless Sets with the Armies in France.

By Capt. B. F. J. Schonland, O.B.E., R.E., late Staff Officer (Wireless) 1st Army, France.

THE great war has seen many marvellous adaptations of man's ingenuity and science as aids to victory. Scarcely a field of knowledge but has had its quietly-won results turned into martial channels, their development hastened by the pressing needs of the time. Science, with all its brain power, all its facilities for research, has had to turn from peaceful paths and to produce new tools for warfare, on sea and land and in the air. With such an adaptation of science and engineering this series of articles has to deal. The story of the work of field wireless sets in France is the story of an entirely new development of the wireless art. A new development, because though our armies were well equipped with field wireless sets before the war, these sets were not of the kind used in France, largely used that is. They were used with our forces in Egypt, Palestine, Salonika, Mesopotamia, East and South-West Africa, when as sole means of communication between units fighting in desert or jungle, advancing rapidly, moving constantly, they did invaluable work. In France the problem was an entirely different one, and prior to the war, the British Army possessed no sets capable of solving it. Though indeed the problem, that of communication in battle in trench warfare, could hardly have been foreseen. How wireless telegraphy solved it, and so successfully that the number of trench wireless sets can now be reckoned in thousands, the following pages will show. I hope, too, that the story of the W/T sections R.E. working as part of the ordinary and extraordinary communication of the huge army in France, as part of the Signal Service, will show that, thanks to the heroism and enthusiasm of the operators, they contributed in no small measure to the final victory.

The wireless sets brought over to France by the original Expeditionary Force in August, 1914, numbered about a dozen. They were 1½ kilowatt sets mounted in lorries or in limbered wagons, the latter for use with

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the cavalry. During the rapid movements of the first few months these stations did a certain amount of good work, but conditions were against their employment to any great extent, as moves were too rapid during the retreat and subsequent advance from the Marne. Once the opposing armies had "dug themselves in" on the fronts that changed so little for four years, these sets were not used and they remained inactive during the year 1915.

The advent of trench warfare, however, and the ever-increasing weight of enemy artillery brought to bear on our trenches, made the problem of maintaining communication with our forward troops very difficult. The great concentration of infantry and guns on a front of attack complicated the scheme of communications. Telephone and telegraph "buzzer" lines had to be laid everywhere. But once an enemy barrage came down, telephone cables were sure to be cut. True, they could be laid along the sides of communication trenches, or buried in special trenches at night, but even the latter expedient was not a sure means of maintaining communication. Though the regulation depth was increased from a foot to six, and even eight feet, a direct hit from a Boche "5.9" would cut the line.

During the latter part of the year 1915 those responsible for organising the work of the Signal Service began to look round for some auxiliary method of communication, to carry back the "S.O.S." of the fighting infantry. Visual signalling by flag or lamp, they had, and the finest visual signallers in the world. But cover from enemy observation was not easy to find in that shell-shattered land. The dust and smoke of a barrage, too, was enough to obscure any flagwagging or lamp-signalling, while many a good visual "circuit" was useless owing to the morning mist, at a time when information was all-important.

Many ideas were tried, some at a later date than that which I am considering. Carrier-pigeons, which did good work while trench-warfare lasted, though subject to many drawbacks, message-carrying rockets, which were never very successful, even messenger-dogs! The infantry "runner" always used in the last extremity, was a brave man, but often it cost him his life which could ill be spared.

And then, about the end of 1915, it was decided to try wireless sets. Possibly some success obtained by our Allies the French led to this decision. Certainly the enemy, from whom we were never unwilling to adopt an idea, as he from us, was not using anything but a few powerful stations for his very long rear communications. Before describing the sets that were tried, I will briefly indicate what was required of them from a military and technical point of view.

Wireless was required as a means of communication between the headquarters of battalions, brigades and divisions, to supplement the telephone and telegraph in case of the failure of the last two through lines being broken by shell-fire or difficult to lay. Later, as we shall see, wireless was required to supplement and even replace all "wire" communications in the army, both in the actual front line and in the area behind the trenches. These wireless sets were to transmit and receive orders and reports during battle and to move forward with our advancing troops. Clearly the range required of them was not great, varying from a thousand yards to ten or twenty miles. The aerials used had, however, to be as low and as inconspicuous as possible, sometimes merely ground aerials, and the sets were to be under conditions of working and screen-

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ing which did not make for efficiency. Moreover, as they had to be quickly dismantled and carried forward, everything about the sets, masts, instruments, accumulators, etc., had to be simple and as small and light as possible. The design and development of these short range trench wireless sets with their special needs and peculiarities, can well claim place as a new branch of wireless engineering.

So in the spring of 1916 there came out to France a number of small "boy-scout" wireless sets, christened at G.H.Q. Wireless Headquarters, the "B.F" sets. History does not relate the origin of this name, and though the succeeding years saw sets which better fulfilled the conditions given above, the "B.F" set is used to this day. Suitable operators, most of them old Marconi men, were obtained from the infantry and other sources, and after a period of training, the B.F. sets had their baptism of fire. They went into "action" in the 1st Battle of the Somme, July 1st, 1916. The map (Fig. 1) shows the distribution of stations during one phase of the battle. Time and again these sets got "through" important messages when all other means of communication failed. Some idea of the conditions under which they worked may be got from the station at Waterlot Farm, on a rise in full view of the enemy, and only about nine hundred yards away from him. To keep two fifteen-foot masts standing was almost impossible, and this station had to use ground aerials (insulated cables laid along the ground for a hundred yards). Some very important messages were yet despatched in this way, and enemy counter-attacks broken as a result.

Lack of facilities for transport and for charging of accumulators and many minor difficulties which occurred were natural with a new organisation, as yet not fully equipped. Opposition and criticism, too, were not absent, but these were to die away later. It was during this Somme offensive that the poor Corps wireless officer, struggling to keep his sets going, with bad carborundum crystals and accumulators which he could not get charged, was daily asked the facetious question: "Hullo, Sparks, got any messages through?" A remark not calculated to help poor "Sparks," who, nevertheless, thanks to the keenness of himself and his men, eventually turned the tables on his interlocutor and—but I am anticipating. However funny it was to some people to see "Sparks" and his men wandering about the trenches with their "gadgets," their portable boxes of wireless magic, to the Huns at any rate they did not seem in the least bit funny. In the captured report on the Somme operations by General von Arnim, the report in which he contrasted our excellent fighting equipment with that of his own troops, he particularly asked that small portable trench wireless stations, such as we had used, should be quickly provided for him. That this was done was evident to us a few months later, when the now familiar Telefunken trench-sets began "U-M"ing all along the line. Imitation is the sincerest form of flattery, and after the *début* of "W/T.R.E.," it was still the British who kept the mastery of the Aether, both in novelty of idea and in general efficiency of service.

The success first obtained on the Somme was maintained in succeeding operations and gradually prejudice and opposition alike were won over. More men and better equipment were provided, with correspondingly better results from wireless communication. Schools were started during the winter of 1916-1917 for Signal Service officers, to give them some knowledge of the

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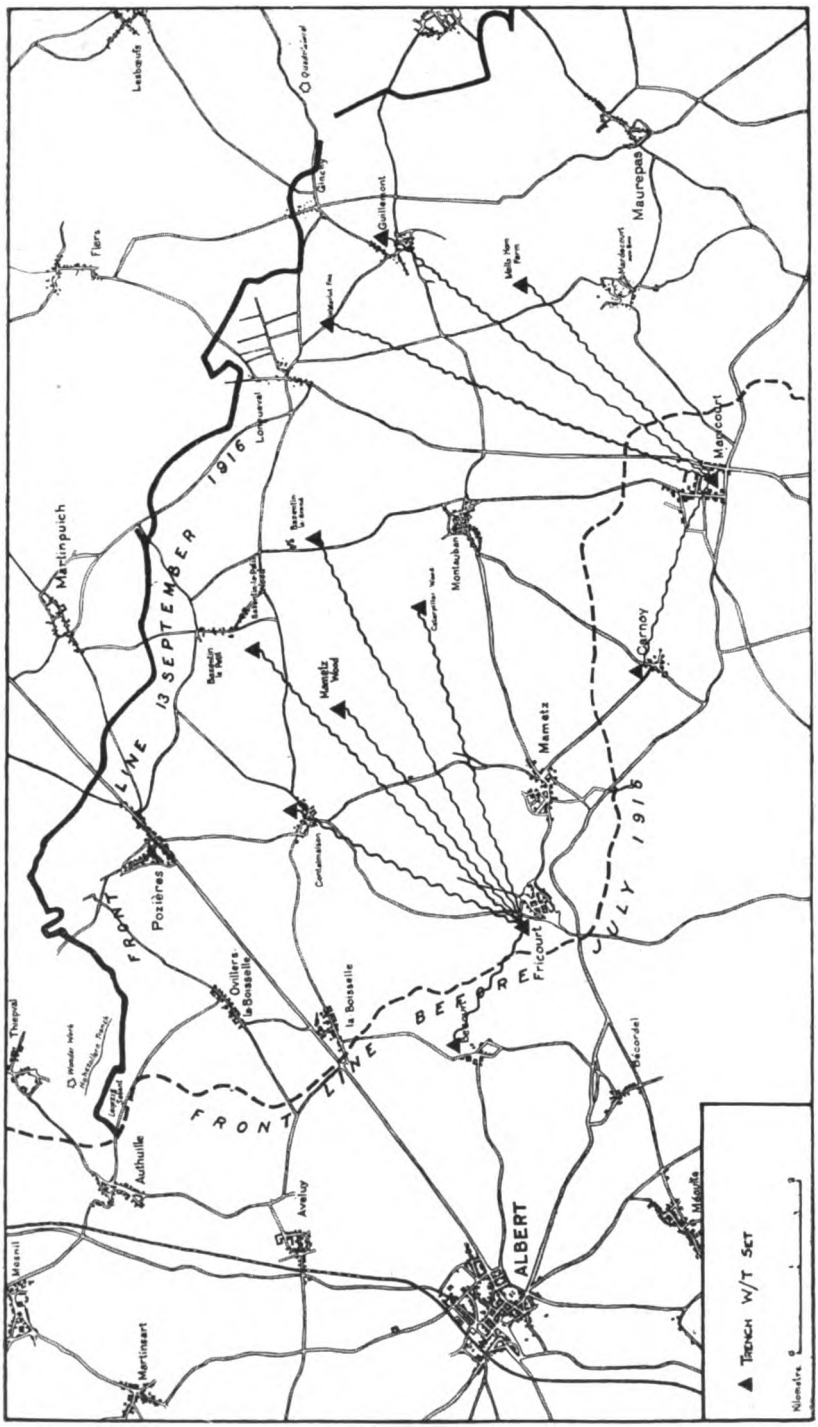

Fig. 1.

Trench Wireless first used in battle. *First Battle of the Somme, September, 1916.*

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working conditions, possibilities and needs of the sets. The number of sets was increased by production in special factories in England, and operators were trained at depots in England and France. The need being recognised, a staff of wireless experts at Woolwich was busy investigating the trench wireless problem, and applying to it all that modern wireless practice could suggest. In particular that revolutionising instrument, the three-electrode valve, was called in to help.

The battles of 1917; the German retirement to the Hindenburg line, Vimy Ridge and Arras, and the battle of Ypres which culminated in the capture of the Paschaendale ridge, all these added to the laurels of the "W/T.R.E."

Amongst hundreds of cases of heroism of the operators and invaluable service to the fighting infantry, I can only mention a few instances. In the first battle of Arras, for example, prior to the commencement of operations, the second corps wireless section had stations erected near the front line in communication with the 73rd Brigade Advanced H.Qrs. At 7 a.m. on April 15th one "B.F." set was moved forward to advanced Battalion H.Qrs. Only visual signalling of doubtful reliability existed until the trench set was established. During the battle visual signalling became impossible and wireless was relied upon to maintain communication. A large number of messages of the utmost tactical importance were sent at critical periods of operations, over an average distance of 8,000 yards. Continuous communication was maintained in spite of heavy shellfire.

During this battle of Arras one of the most important objectives was a peculiar hill crowned by the village of Monchy-le-Preux. This hill commands the country for miles around. The possession of it was invaluable to our artillery observers and a great loss to the enemy. The hill and village on top were captured in a rush, the Boche retiring in disorder to the valley beyond. Owing, however, to the speed of their advance our troops were out of touch with the higher command, and the guns behind them. Out of touch, did I say? What is this queer mast affair some sappers are rigging up in the garden of what was once a pretty cottage? Up go the small steel masts in spite of the shells streaming into the village, which seem determined to wipe out this and every other cottage before many minutes are over. The aerial up, it is not long before they have installed their tiny set in the cellar and are "through," R9 signals each way. Just in time, too, for the Boche at the foot of the hill show signs of a counter-attack. "Get at the guns, Sparks, get at the guns!" And "Sparks" bends to his key, like operator on sinking ship. "S.O.S. Barrage, S.O.S. Barrage, S.O.S. Barrage" goes out on 350 metres for every battery of artillery behind to pick up. They do pick it up. Within a minute the answer comes as the shells whistle overhead. The German counter-attack withers away under our shelling, and Monchy is saved. For several hours afterwards the little set keeps the garrison in touch with the general and the guns behind until a telephone line can be laid.

The third instance is concerned with a continuous wave set. These sets were introduced about the middle of 1917 and proved very successful, later designs giving admirable results. The very low and short aerials on which they would work made it possible to instal them in positions under enemy observation and in very forward positions. They were therefore utilised for directing artillery fire from forward O.P.'s (Observation Posts). *(To be continued.)*

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COLONEL BLANDY, D.S.O.

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Personalities in the Wireless World.

THE subject of our biography this month, Colonel Lyster Fettiplace Blandy, D.S.O., Royal Air Force, now in charge of "Communications" at the Air Ministry, was educated at Haileybury College and the Royal Military Academy, Woolwich. He was given a commission in the Royal Engineers in March, 1895, and after passing ten years in Bermuda, the West Indies, and Canada, engaged on work in connection with submarine mining and coast defence search-lights, he returned to England. For two years he was employed at Pembroke Dock, and from 1908 to 1912 as Inspector R.E. Stores at Woolwich. During this period he had considerable work to do with the field wireless sets which were being perfected at this time for our Army.

From Woolwich Captain Blandy, as he then was, went to Aldershot at the beginning of 1913 to command a small unit of 30 to 40 men, the Wireless Signal Company which was destined to be the nucleus at General Headquarters of Wireless in the British Army if war should break out. The only other unit at that time was the Wireless Signal Squadron, a unit whose object in life was to work with Cavalry and maintain wireless communication with Headquarters.

On the outbreak of war Captain Blandy proceeded to France in charge of an advance party to make the preliminary signal arrangements for G.H.Q. Arriving at Le Cateau on August 13th, 1914, he supervised general Signal work during the retreat, the advance to the Aisne, and the movement to the Belgian frontier, and was shortly afterwards given charge of the wireless communications of the army, being responsible for the development of these up to July, 1917, when he was brought home to take charge, as Chief Experimental Officer, of the Army Signals Experimental Establishment. On the formation of the Royal Air Force in April, 1918, Colonel Blandy was appointed Chief Experimental Officer of the R.A.F. Wireless Experimental Establishment, and from there was transferred to his present post in the Air Ministry.

Colonel Blandy has received the following decorations, besides being mentioned in despatches, for his services during the war:—The D.S.O., the French Legion of Honour, the Order of the Crown of Belgium, the Belgian Croix de Guerre.

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The Theory of Valve Rectification

By W. S. Barrell.

ONE of the many uses to which the thermionic valve is put is that of rectification, and it is proposed to outline the elementary theory of this function, firstly, in the case of the two-electrode or Fleming valve, and, secondly, in the case of the three-electrode valve.

To begin with, it should be borne in mind that whichever type of valve is being used the fundamental basis of its operation is the same, for both depend, for working, upon thermionic currents.

The nature of the phenomena in a valve will depend a great deal on the degree of vacuum produced within the tube, i.e., whether the valve is what is popularly known as hard or soft, but in what follows we shall only deal with valves that have been well exhausted, and are known as hard, the degree of vacuum being about 10^{-5} mm. pressure of mercury. In this class of tube the current between the electrodes will be strictly thermionic, the absence of gas rendering the presence of positive ions impossible.

Previous to the invention of the Langmuir pump it was generally accepted that unless gas was present in the tube electronic emission could not take place. Langmuir was able to show, however, that not only was the presence of gas quite unnecessary for the emission of electrons but that this emission was much more regular in hard tubes. He further showed that it followed definite laws, and formulated the equation for the emission from a filament surrounded by a cylinder charged to any given potential.

$$I = 14 \cdot 65 \times 10^{-6} \frac{l}{r} (V^{\frac{3}{2}})$$

where I = current in amperes
l = length of cylinder
r = radius of cylinder
V = Potential of cylinder in volts.

NATURE OF THERMIONIC CURRENTS.

In any conductor there are present minute negatively-charged particles which are known as electrons. If the conductor be raised to a high temperature the activity of the electrons is considerably increased and a number will break through the surface layer. The number of electrons which escape in this manner per unit area of the conductor is proportional to the temperature of the conductor and the material of which it is made.

Professor Richardson has shown that the number of electrons emitted per sq. centimetre per second is

$$N = aT^{\frac{1}{2}} \epsilon^{\frac{-b}{T}}$$

where T is the absolute temperature of the filament, a and b are constants depending upon the material, and $\epsilon = 2 \cdot 718$.

Now these electrons are negative charges of electricity each representing 10^{-19} coulomb. If, then, no attractive force be applied, these electrons will return to their source, the filament, but, on the other hand, it will readily be seen that if a positively charged anode be placed in the tube and the filament raised to incandescence the electrons will be attracted towards the anode and absorbed by it.

We shall thus have a negative current passing from the filament to the anode, but not in the opposite direction.

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RECTIFICATION BY THE FLEMING VALVE.

In order to simplify the study of valve rectification it will be necessary to draw what is known as the "Characteristic Curve of the Valve." It has been found that if the filament heating current is kept constant and a varying voltage applied to the anode we shall get varying readings of current in the anode circuit, the current variations depending upon the variations in voltage. We thus have our independent and dependent variables and can plot a curve with values of anode current as ordinates and anode volts as abscissæ.

There are several ways of connecting up a circuit for curve drawing, and perhaps the one most easily understood is that shown in Fig. 1.

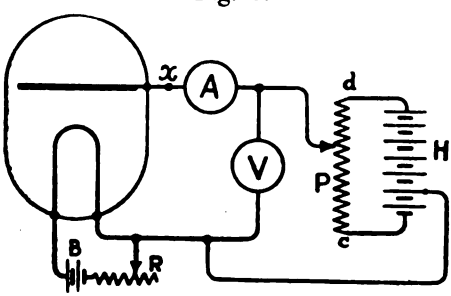

Fig. 1.

The filament is lighted by a 4-volt accumulator B, the series resistance R being adjusted to give a current of approximately 0·37 amp. H is a battery of a few dry cells, and is so arranged that in conjunction with the potentiometer P any voltage may be applied to the anode, its value, either positive or negative, with respect to the negative end of the filament, being indicated by the voltmeter V. A is a micro-ammeter and serves to measure the anode current.

It is advisable to break the voltmeter circuit when reading the current on the micro-ammeter A, but if the former be connected across the micro-ammeter as well as across the battery (i.e., if the upper lead be connected to "x" instead of where shown) then the foregoing proviso is *absolutely necessary, for with the voltmeter circuit complete the instrument A will register the current flowing through the voltmeter as well as that flowing through the valve.*

Our circuit being all ready we will proceed to take a series of readings. Commencing with the potentiometer slider at c and closing the voltmeter circuit, the potential of the plate will be indicated. If our instrument is of the central zero type it will at once show whether the plate potential is positive or negative with respect to the filament. Suppose the reading to be −3, the current flowing through A is then measured and will probably be zero. This procedure should be repeated for different positions of the slider P, say every ½ volt, up to the position where the slider is at d. We shall thus have two sets of readings—one the values of V, the other the values of current I, and plotting the former as abscissæ and the latter as ordinates we shall find that a curve such as is shown in Fig. 2 is given.

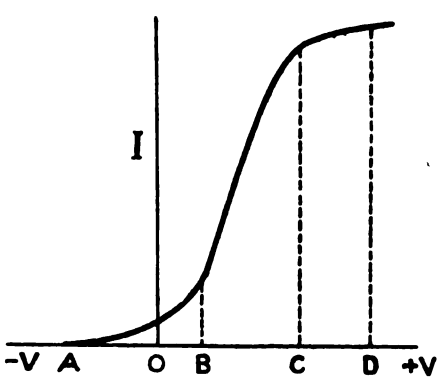

Fig. 2.

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The reader will at once notice that the shape of this curve bears a striking resemblance to the characteristic curve of a carborundum crystal in that it may be divided roughly into three parts, each being almost a straight line. The slope of the part AB is about the same as the portion CD, BC being much steeper; in the latter case dI/dV being obviously much greater.

In this, as in the case of the carborundum curve, it will be evident that up to a certain point B an increase in voltage V will cause but a small increase in the current I, but if the same increase of voltage be applied after this point a greater increase in current will follow. Again, after passing the point C the current remains practically constant, provided the filament current remains uniform, or, in other words, saturation has been arrived at.

In Fig. 3 is shown a two-electrode valve connected to a simple receiving circuit for the reception of spark signals (damped waves).

It will be seen that the plate and filament of the valve are connected across the oscillating circuit, and that instead of using a separate battery for the anode potential the low tension accumulator battery has been utilized. A potentiometer c d of about 250 ohms is joined across the cells, and the slider P allows the potential of the plate to be adjusted to the point B (see Fig. 2) which, as we shall show, is the best position for rectifying.

In order to state a definite case and for ease in explanation we will assume that the incoming wave gives a variation of +1 and −1 volt, the position of the potentiometer slider being adjusted to give the plate a zero potential. From Fig. 4 it is seen that normally a current of .02 micro-amps. will flow through the telephones, producing a steady deflection. This is represented by Xa Fig. 4. The positive half wave will increase the plate potential to +1 volts with a consequent increase of current to 0·62 micro-amps. shown by X_1b. The negative half wave will, however, reduce the anode potential to −1 volts with a reduction in plate current to 0·001 micro-amps. This is represented by $X_2\ b_2$. A study of Fig. 4 will show that the increase in plate current due to the positive half waves is greater than the decrease due to the negative half waves and that the

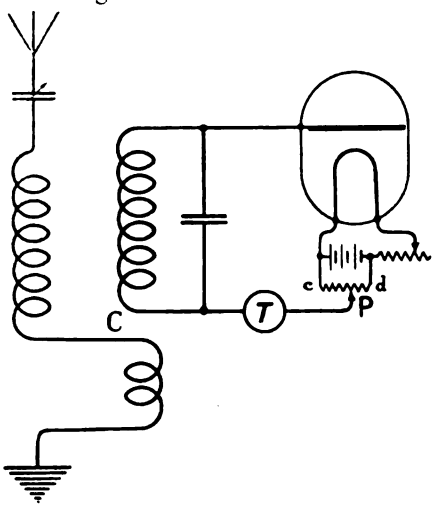

Fig. 3.

mean increase is equal to $Xa_1 - Xa = Y$. This then is the current through the 'phones, and we may, for convenience, say that the signal strength is equal to Y. Now let us suppose that the amplitude of the incoming wave is but one-half of the previous example; this will give a variation of only ±·5 volt. The positive half wave in this case will increase the plate potential to +.5 with a current increase from .02 to .2, and the negative half waves will cause a reduction in current to .006, these two current values being represented by ZZ^1 and Z_1Z^2 respectively (Fig. 4). Taking a_2 as the mean increase and a as the normal we have a signal strength in this

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case equal to W which is $\frac{1}{4}$Y. This shows that with one-half the amplitude the signal strength is reduced to one-quarter. Now $\sqrt{\frac{1}{4}}=\frac{1}{2}$ and in general the signal strength is proportional to the square of the amplitude of the incoming oscillations. From the foregoing the reader will at once appre-

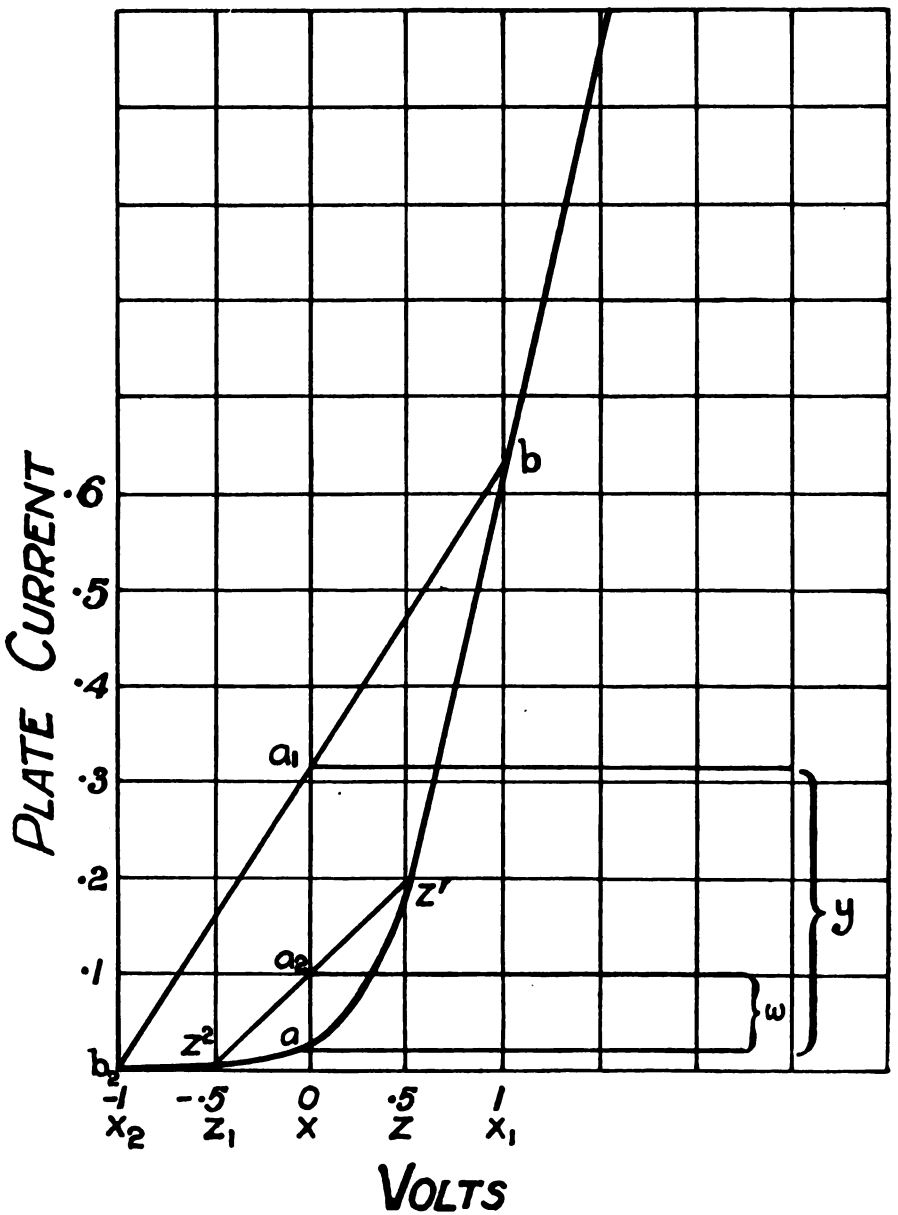

Fig. 4.

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ciate the enormous value of reaction and high frequency magnification which increase the amplitude of the waves affecting the receiving aerial.

In connection with the characteristic curve shown in Fig. 2 a very interesting experiment can be made by plotting the sensitivity curve on the same paper. The circuits needed for this experiment can be arranged as shown in Fig. 5 where the valve circuit is fundamentally the same as in Fig. 1 but with the addition of a coupling coil L, tuning condenser C, and telephone transformer. A buzzer set B is also set up and tuned to some convenient wavelength. This latter should preferably be arranged on a small board so that the distance x between the two coils L and L_1 can be easily varied. First of all the wavelength of the valve circuit is tuned to that of the buzzer set by means of the variable condenser C and once having the two circuits syntonized the characteristic and sensitivity curves may be plotted simultaneously. Commencing with the potentiometer at c, as already explained, the current through A is read, these two readings giving the first point on characteristic curve. An additional reading has now to be taken. Assuming the circuits in tune and the buzzer working, the distance x between coils L and L_1 is varied until the buzzer signal is just audible. This distance is carefully measured and plotted as the ordinate against voltage V as the abscissa and gives us the first point on the sensitivity curve. Thus for every position of the slider P along the potentiometer cd a reading of the current through A is taken and also of the distance x between the coils L and L_1. I plotted against V provides the characteristic curve, and x against V the sensitivity curve.

Fig. 6 shows these two curves plotted on the same paper. From the sensitivity curve we see that there are two points on the characteristic curve which give the strongest signals, one being at the lower and the other at the upper bend. This is as might be expected because the two bends are about the same, the difference in actual working being that if the upper bend is used there will be a reduction in anode current for each signal instead of an increase as when working at the lower bend. It should further be noted that the sensitivity of the particular valve from which this curve was plotted is slightly greater at the upper bend. About the middle of the curve the sensitivity is at a minimum, this point being known as the "Balance point." Certain precautions such as screening are necessary in performing this experiment in order to prevent direct action from the buzzer on to the telephone transformer,

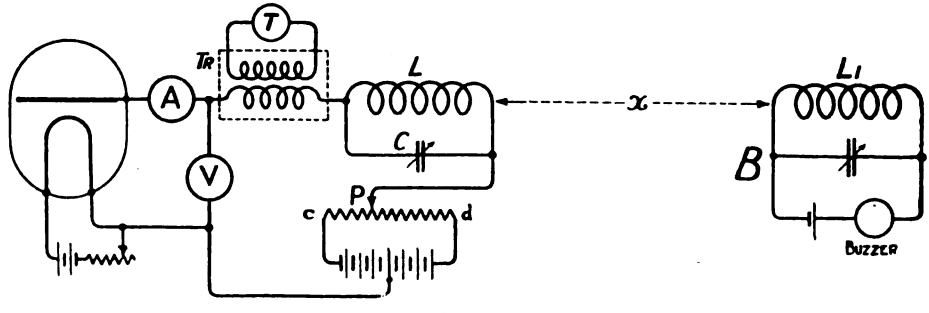

Fig. 5.

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etc., with consequent faulty readings. It should also be remembered that the coils L and L_1 must always be strictly parallel to each other throughout the test. It is possible to perform the experiment by rotating the coil L_1, instead of increasing or decreasing its distance from L, and noting the angle through which the coil is turned. This method, however, is rather elaborate, and the distance method is, at any rate for the student, to be recommended.

It was stated above that the distance between the buzzer and valve set was varied until signals were just audible. As a matter of fact any strength of signal will do equally well, *provided this same signal strength is maintained throughout the experiment*, and as it is very difficult to estimate strengths accurately it is much better to arrange the distance so that signals are just on the vanishing point.

(*To be continued.*)

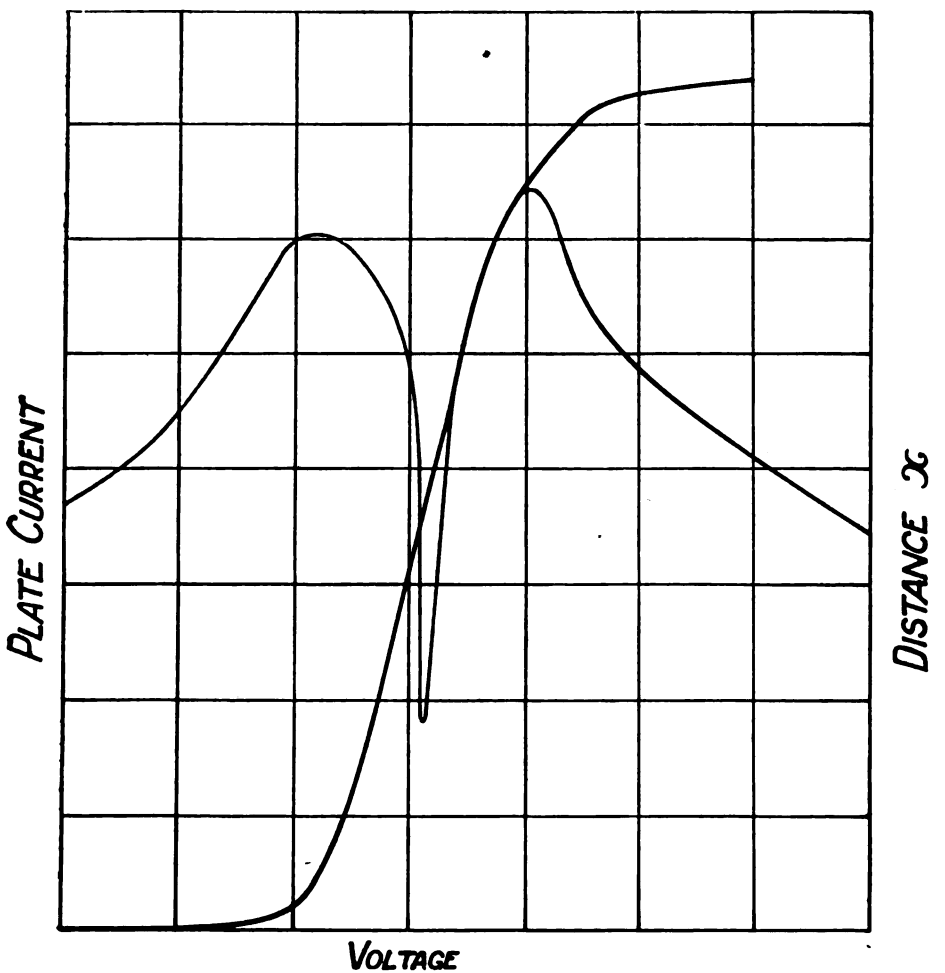

Fig. 6.

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Digest of Wireless Literature

HIGH FREQUENCY ALTERNATORS.

By M. LATOUR.

Abstract of Paper read before the Société Internationale des Electriciens.

FOR several years it has been possible to construct on a commercial scale high power alternators (i.e., of larger size than 100 kw.) of which the natural frequency corresponds to that of the electrical oscillations in wireless aerials. It has thus been possible to excite these aerials directly by the alternators without the complications of any species of transformation, and with all the advantages of transmission by undamped oscillations.

It is proposed to discuss in the following pages the different types of machine which are available for the generation of high frequency currents; but not the means whereby it is possible to increase the frequency of the current outside the alternator, by means of doubling or tripling transformers. This discussion is limited solely to these types of alternator which yield directly, without any external apparatus, the frequency necessary for the excitation of radio-telegraphic aerials.

The various arrangements may be classified as follows:—

1. Machines in cascade,
2. Internally-cascaded machines,
3. Homopolar disc machines,
4. Variable reluctance alternators,
5. Alternators utilising part only of the armature periphery.

1. *MACHINES IN CASCADE.*

In 1904 machines had been constructed giving a frequency of 10,000 periods per second; and in particular Lamme had presented a paper to the American Institute of Electrical Engineers* giving specifications of a homopolar machine with an output of several kw., at 10,000 ~ using only a relatively moderate peripheral speed.

The production of a frequency of the order of 80,000 periods appeared to be hardly possible without the employment of some special arrangement, such as the connection of several machines in cascade.

Figure 1 indicates one such arrangement. For example take four machines A_1 B_1; A_2 B_2; A_3 B_3; A_4 B_4, having the same number of poles and mounted

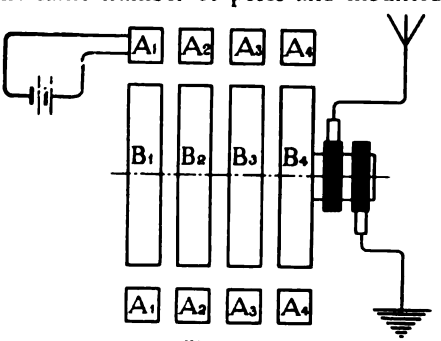

Fig. 1.

upon the same shaft. The stators and rotors of these machines carry windings which we may take as being two-phase. The first machine A_1 B_1, is excited by direct current in A_1, and yields two-phase currents of frequency f from the winding B_1. These currents of frequency $=f$ are collected from B_1 by means of slip rings (not shown in the figure) and excite the two-phase windings on the inductor A_2 of

*B. G. Lamme, Trans. American Institute of Electrical Engineers, 21, p. 405 (1904).

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the machine A_2 B_2, so that the resulting rotating field revolves in the opposite direction to the rotation of the shaft. Two-phase currents of frequency $2f$ are thus set up in B_2. These are utilised for supplying the inductor A_3 of the machine A_3 B_3 producing a field rotating in the opposite direction to the shaft. The currents set up in B_3 have thus a frequency of $3f$. Finally these currents of frequency $3f$ serve to excite the windings of A_4 of the machine A_4 B_4. A current of frequency $4f$ is thus obtained in B_4 which supplies the aerial.

Thus the frequency may be multiplied indefinitely by increasing the number of machines. With n machines a current of frequency nf would be obtained, f being the natural frequency of each machine.

It is possible to remove the complication of the slip rings between the successive circuits, as well as the slip rings on B_4, by making the fixed and moving parts (stators and rotors) serve alternately as fields and armatures. Referring to the figure it is merely necessary that A_1, B_2, A_3 and B_4 should serve as fields, and B_1, A_2, B_3, A_4 as armatures. The connection between the machines could be made through condensers in order to annul the effective reactance of the windings. In 1912 M. Bethenod constructed the first high frequency alternator based on the principle shown in Figure 1. In this experimental alternator, each elementary machine had a fundamental frequency of 6,000 cycles.

An output of the order of 1 kw. in the aerial was obtained at $4 \times 6000 = 24{,}000$ cycles per second.

This system of machines in cascade shows particular advantages for very high powers. For example, supposing that it is desired to obtain 500 kw. in the aerial at a frequency of 15,000. Two groups of machines may be used each comprising two elementary machines designed to give 250 kw. at 7,500 cycles per second. Putting these in cascade, the two groups would yield 500 kw. at 15,000 ~ . Alternatively three groups would be possible each comprising two elementary machines designed for 166 kw. at 5,000 cycles. Putting these in cascade, the three groups would yield 500 kw. at 15,000 periods.

2. *INTERNALLY-CASCADED MACHINES.*

In 1893 M. Boucherot enunciated the following theorem*

"In a suitable alternator with alternate poles of opposite polarity, the armature system is the seat of an E.M.F. and a current represented by an infinite series of odd terms of the Fourier series; and the inductor the seat of an E.M.F. and a current represented by an infinite series of even terms of the Fourier series."

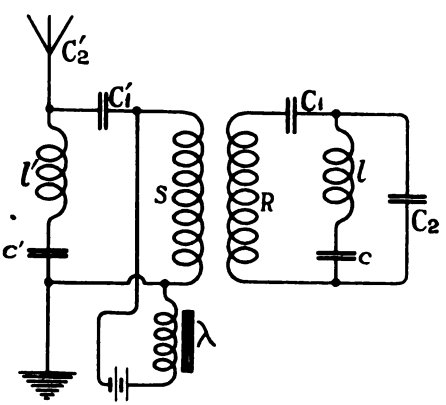

Fig. 2.

The alternator due to M. Goldschmidt, represented diagrammatically in Figure 2 was the practical outcome in 1907 of the ideas put forward by M. Boucherot in 1893. The stator and rotor of the high frequency single-phase

**Lumière Electrique*, March 25th, 1893, p. 554.

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alternator of the Goldschmidt type are indicated in the figure by S. and R. In this alternator the odd multiple frequencies f and $3f$ are set up in the rotor and the even multiple frequencies $2f$ and $4f$ in the stator, this last frequency $4f$ becomes the output frequency. The rotor circuit is closed by a system of inductance and capacities so that it is in resonance for the two frequencies f and $3f$—the branch lc forming a short circuit for the frequency f, and the condenser C_2 combined with the rotor inductance tuning to the frequency $3f$. In the stator circuit, which is excited by a continuous current through the protective choke λ, is arranged the system of inductances and capacities l' c', C_1', C_2' to tune the stator to the frequencies $2f$ and $4f$. The capacity C_2 represents the aerial capacity.

The current of frequency f set up in the rotor gives rise to an alternating magnetic field, which may be resolved into two rotating fields of half the strength. One of these rotating fields is turning in the same direction as the movement of the rotor at the frequency f and thus sets up a current of frequency $2f$ in the stator, in a similar manner to the separate machines in cascade. The current of frequency $2f$ gives rise to an alternating magnetic field, which may in turn be resolved into two rotating fields one of which revolves in the opposite direction to the shaft and rotor. This sets up a current of frequency $3f$ in the rotor. The current of frequency $3f$ similarly sets up a current of $4f$ frequency in the stator. In effect the machine Figure 2 represents in a single machine the summation of the four cascaded machines of Figure 1.

3. *HOMOPOLAR DISC MACHINES.*

The homopolar machines with rotating iron disc do not carry any windings upon the moving part. This is an important advantage when high peripheral speeds are considered. This type of machine has been employed for some time to obtain high frequencies. M. Thury between 1893 and 1900 constructed a number of homopolar machines for 10,000 ~ frequency. One of these exhibited in 1896 had a rotating inductor with 200 polar projections revolving at 3,000 r.p.m. for a frequency of 10,000. At this frequency the output was 3 – 4 kw. with an open-circuit voltage of 150 volts.

In 1904, M. Lamme constructed a similar machine, but using for the first time specially thin laminations (0.075 mm. thick). The diameter of the inductor was 62 cms., the speed 2,000 r.p.m. and peripheral speed 100 metres per second.

M. Alexanderson has constructed homopolar machines with a disc form to allow of peripheral speeds higher than 200-300 m/sec. Figure 3 indicates an alternator of this type. The coil B provides the exciting field which traverses the disc A and the polar lamina-

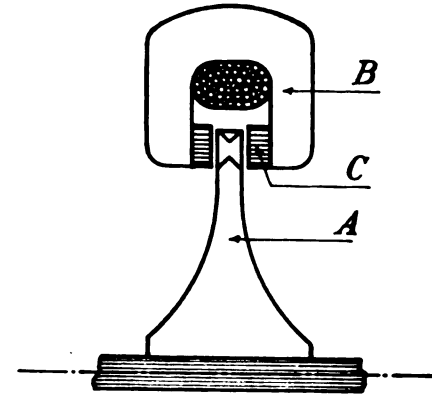

Fig. 3.

tions C. The windage losses are reduced by filling in the spaces between the polar projections with non-magnetic material. In later forms these fillings

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of non-magnetic metal are joined together to form a damping system. In these machines the hysteresis losses are higher than in the ordinary type of alternator with alternate poles.

4. *VARIABLE RELUCTANCE ALTERNATORS.*

An early form of variable-reluctance alternator is shown in Figure 4. It comprises an excitation winding on the stator which constitutes at the same time the working winding by introducing the choking coil shown in the figure. When the rotor teeth are opposite the stator the flux is a maximum through the stator teeth; when the spaces are opposite the stator teeth the flux is a minimum. An E.M.F. is thus obtained, having the same frequency as that of a homopolar machine with the same number of teeth on the rotor. The rotor must be laminated as the flux is variable.

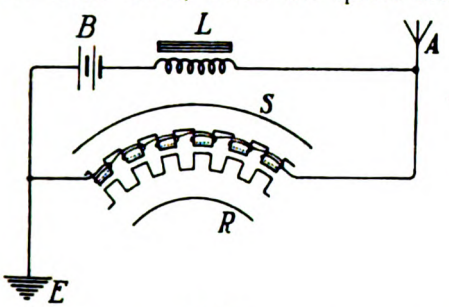

Fig. 4.

For high frequencies the rotor teeth are small and close together, and the effective flux variations are small compared with the total flux. Further, the flux in the rotor teeth changes its direction for each pole pitch passed over so that the losses in the rotor should be larger than in the stator. The output of the variable impedance machine is much less than that of the homopolar machine in which the rotor polar projections are always traversed in the same direction by the main flux.

The variable impedance machine may equally be made of the homopolar form. In this case the central exciting winding is traversed by a variable flux depending upon the relative position of the rotor and stator teeth exactly as in Figure 4.

(To be continued.)

Photo Topical Press Agency

The Wireless Telephony Apparatus in use at Marconi House during the recent Demonstration.

(See page 199.)

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Stray Waves.

NOMENCLATURE IN WIRELESS TELEGRAPHY.

DOUBTLESS owing to the rapidity with which the art has developed little attention has been devoted to the question of suitable names for wireless telegraph apparatus, phenomena and processes. The Army, the Navy, the Air Force, private manufacturers and private experimenters have during the past four years been engaged in inventing, developing and perfecting wireless appliances with the primary object of beating the common enemy, and their creations have been hurried off to their respective spheres of usefulness without formal christening. This is especially true of valves, for which there has been such an enormous and urgent demand. Now, however, that the world has time to breathe, it certainly is desirable, before we go any further, to make an attempt to select and standardise the names of certain parts of the modern wireless installations, more especially on the receiving side and in connection with thermionic valves.

The indefatigable Dr. W. H. Eccles, has given this idea a very business-like fillip with his suggestive article which appeared in *The Electrician* for April 18th, 25th, and May 2nd; indeed, there is evidence that it was in his mind as far back as 1917, for in his article on Ionic Valves (Year Book of Wireless Telegraphy and Telephony, 1917), he devoted a certain amount of space to it. Dr. Eccles now suggests that "a vacuous space containing three electrodes" shall be called a "tri-electrode" or "triode," and following up the notion, that valves with two, four and five electrodes should be respectively styled "diode," "tetrode" and "pentode." Now, although we think these names are excellent and quite suitable for use in "valve" literature or in text-books we do not believe that they will win popularity amongst wireless engineers and operators, that is, amongst the men who have to handle and use valves. They are really too academic and refined to become familiar, and one must remember, too, that there are still certain difficulties opposing their use. Dr. Eccles himself refers to these. It seems to us a better plan to distinguish the various valves by names indicative of their usual functions in radio-work—"two-electrode high power" and "two-electrode low power" (for rectification), "three-electrode high power" (for wireless transmission), "three-electrode low power" (for rectifying and amplifying received currents) and so on. Such words, coupled with the names of the men associated with particular forms of valves, Fleming, Round, etc., should prove far more attractive and handy. The standardisation of names does not necessarily call for extreme refinement of word-building.

Mr. J. Scott-Taggart in a letter to *The Electrician*, makes the pertinent suggestion that the "high-tension" battery would be more correctly described as the plate or anode battery. In earlier days, when the plate battery had a p. d. of some 200 volts the former name was quite appropriate, but now that we work with voltages ranging from 4 to 50 volts it has become a misnomer; "plate battery" whether in any specific case a separate battery or the filament battery is used, seems to cover

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all requirements. The use of "cathode battery" follows as a matter of course.

PROGRESS OF WIRELESS TELEGRAPHY.

In our April number we published a letter from Mr. Godfrey C. Isaacs to *The Electrician* in which he defends British enterprise and invention against the insinuation that they have contributed but little to the development of wireless work. This letter elicited the following from Mr. Lee de Forest:—

(*Electrician*, May 2nd, 1919.)

Sir: In your issue of March 7th you publish a letter from Godfrey C. Isaacs. He makes therein two statements which are so astonishing that I must ask further elucidation thereof.

First: Why does he now for the first time intimate a distinction between "the three electrode valve" and the Fleming invention? We have always been taught by the Marconi writers that they were the same.

Second: Why would not "all the developments of the three electrode-valve" have been possible "without Dr. Fleming's great invention," since both are clearly and admittedly direct developments from the "Edison effect" lamp?

Third: By what warranty of truth, or fact, is the "Poulsen arc" continuous-wave system, which has transmitted messages over the record distance of 12,000 miles a "Marconi" (whatever that is) developed entirely in this country by Marconi himself, with the assistance of British engineers?

The technical world knows to-day that the arc was Poulsen's invention, developed to commercial high power by C. F. Elwell and Fuller, both American engineers, and rather recently "adopted" by the Marconi Company to replace their obsolete spark system; now Alexanderson's high-frequency generator, with his magnetic amplifier and the audion modulator, is being adopted for the "Marconi" trans-Atlantic telephone "press service.' But this letter of Mr. Isaacs is the first attempt I have yet seen to specifically claim "the long-distance continuous wave system" as an actual Marconi invention or development. I believe your readers are entitled to further elucidation.—I am, &c.,

LEE DE FOREST.

New York, April 7th, 1919.

Mr. Isaacs' reply is as follows:—

(*Electrician*, May 19th, 1919.)

Sir: I have read Mr. Lee de Forest's letter published in your issue of the 2nd instant. He would appear to be strikingly ignorant of the past history and present developments of wireless telegraphy. His letter is so full of inaccuracies that I have neither the time nor the inclination to correct them, except upon one point.

The Committee of eminent scientists appointed by the Postmaster-General in 1913, and which sat under the presidency of the late Lord Parker "to consider and report on the merits of the existing systems of long-distance wireless telegraphy" reported that

"The only continuous high-frequency generator we have yet seen tried with success over long distances is the Marconi continuous high-frequency machine. . . ."

It was this system, erected at the Carnarvon Wireless Station, which has proved itself able successfully to transmit messages to Sydney, Australia. No Poulsen arc, or any other arc, had anything whatsoever to do with this world's record in wireless telegraphy.—I am, &c.,

Marconi's Wireless Telegraph Co. Ltd.,
GODFREY C. ISAACS,
Managing Director.

London, May 5, 1919.

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WIRELESS TELEPHONY AND AIRCRAFT.

A short article under this heading which we published in our May number has resulted in a letter from Mr. E. Sahnow, Ex-Wireless operator, R.A.F., who says:—

"Everybody knows that the Wireless Telephone was invented and even perfected to a certain degree before the commencement of hostilities by the Marconi Co., but surely it is realised that its perfection and installation as applied to aircraft is solely the work of the R.A.F. experts.

The daily press were quite correct when they credited the R.A.F. with having perfected Radio Telephony between ground and aircraft and *vice versa*, even though it may have been found necessary to encroach on previous discoveries (owing to the urgency of the situation) of the Marconi Co., in order to do so.

May I also ask, with reference to your statement 'that the ability of the operator to hear messages in spite of the deafening noise of the engine is chiefly due to a modification of the Fleming Valve and its circuits as worked out by a Marconi Engineer,' whether the said engineer was, albeit a Marconi man, in or engaged with the R.A.F.?

No one would wish to discredit the Marconi Co.'s splendid work during the past years, but why do I so constantly see articles which lead one to believe that without the Marconi Co., the wireless of the world could not be carried on? Is it merely an ingenious advertising device or is there really some cause for grievance?

Take all the credit due to you by all means but please do not try to lower the prestige of that most excellent body of men, the Wireless R.A.F."

When we wrote the article to which our correspondent objects our desire was simply to put on record actual facts, not with a view to advertising for any company or discrediting the R.A.F. We should do the same if it were a similar point at issue between *any* two organizations or inventors. We said that the general tendency of the press had been such as to lead the public to believe that the Royal Air Force had invented and perfected the art of wireless telephony, and we gave our reasons, with which our correspondent apparently agrees, for stating that such a belief is erroneous. We admitted freely that improvements and refinements in wireless telephone apparatus as carried on aircraft had been made possible by actual war experience and indicated that what remained for the R.A.F. to do was the adaptation of the apparatus to the special conditions which arose when it had to be fitted to aeroplanes. If Mr. Sahnow admits that in perfecting the adaptation of wireless telephony to aircraft it was found necessary to encroach on previous discoveries, then he concedes our point and in no way is any discredit reflected upon the R.A.F.

The first wireless telephony set used in this country in connection with aircraft was produced by a Marconi engineer, using Marconi circuits and valves. This was worked out in the summer of 1915 and priority over all other experimenters can be claimed for it.

We do not think that our readers will share in Mr. Sahnow's insinuation that we have tried to lower the prestige of the R.A.F.; indeed, the appointment of an ex-officer of that Force as our Aviation Wireless Correspondent, goes a long way in support of our plea of "not guilty." Mr. Sahnow's *esprit de corps* is most commendable, but we feel that in writing his letter he has been influenced more by feelings than by facts.

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An Alternative to "Fleming's Rule"

By A. Benjamin.

IT was whilst attending a course of lectures at the Military School of Electric Lighting, Gosport, that it occurred to the writer that it would be an advantage to have a more facile rule than Fleming's for determining the relation between lines of force, motion of a conductor, and direction of current. Necessity proved the mother of invention, for sitting in cramped desks is not conducive to the easy performance of the digital gymnastics demanded by Professor Fleming's otherwise excellent rule.

The following rule will, I think, prove easy to remember and apply.

GENERATOR RULE.

Let the direction of lines of force when passing *from left to right*, as in Fig. 1, (i.e., the same direction as that of handwriting) be called the "positive" direction; and the opposite direction "negative," as in Fig. 2.

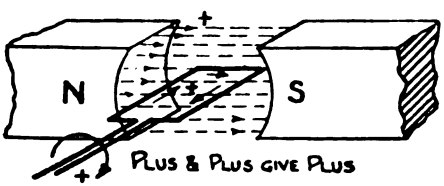

Fig. 1.

Let the *clockwise* rotation of the rectangular conductor in Fig. 1 be called the "positive" direction of motion, and the anti-clockwise rotation, as in Fig. 2, "negative."

Further, let the *clockwise* direction of the current round the conductor, as in Fig. 1, be termed "positive," and the reverse direction, as in Fig. 3, "negative."

Then, given any two factors, the third may be determined by applying the algebraic rule of multiplication or division, namely, that

(a) Two positives yield a positive,
(b) Two negatives yield a positive,
(c) A positive and a negative yield a negative.

Thus, in Fig. 1, we have

Lines of Force = *plus*,
Motion of Conductor = *plus*,
Therefore, Direction of Current = *plus*,
(or clockwise as indicated).

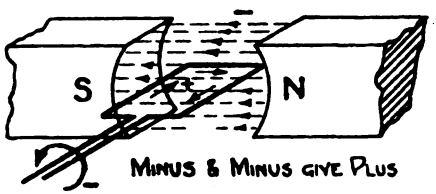

Fig. 2.

In Figure 2 we have

Lines of Force = *minus*,
Motion of Conductor = *minus*,
Therefore, Current = *plus*,
(i.e., still clockwise).

In Figure 3 we have

Lines of Force = *plus*,
Motion of Conductor = *minus*,
Therefore, Current = *minus*,
(or anti-clockwise).

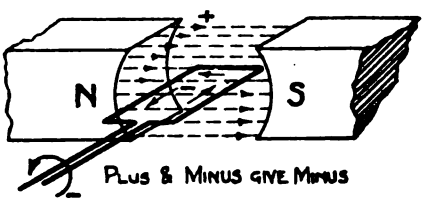

Fig. 3.

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The rule can quite easily be applied to a simple straight conductor in a magnetic field by imagining this conductor to be either the left or right arm of the rotating rectangle in the first three figures.

Thus, in Fig 4, if we are given the polarity of the magnets, and are

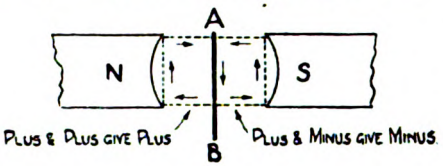

Fig. 4.

told that AB is moving downwards, then, if we think of AB as the *left* arm of the rectangle, we have *positive* lines of force with *negative* (anti-clockwise) motion of conductor, producing *negative* direction of current, which, in AB, is from A to B. If we had imagined AB to be the *right* arm of the rotating conductor, we should still have as the result the current flowing from A to B.

If the poles are oblique, instead of horizontal, or are even vertically one above the other, it is quite simple to imagine (without actually performing the contortion) the body turned so that the left hand coincides with the upper pole.

In the above illustrations, we have taken lines of force and motion of conductor as the two factors given in each case, but if *any* two factors be given, the third may be deduced by the above rule.

MOTOR RULE.

For a motor, instead of using the left-hand rule, simply reverse the answers given by the above generator rule.

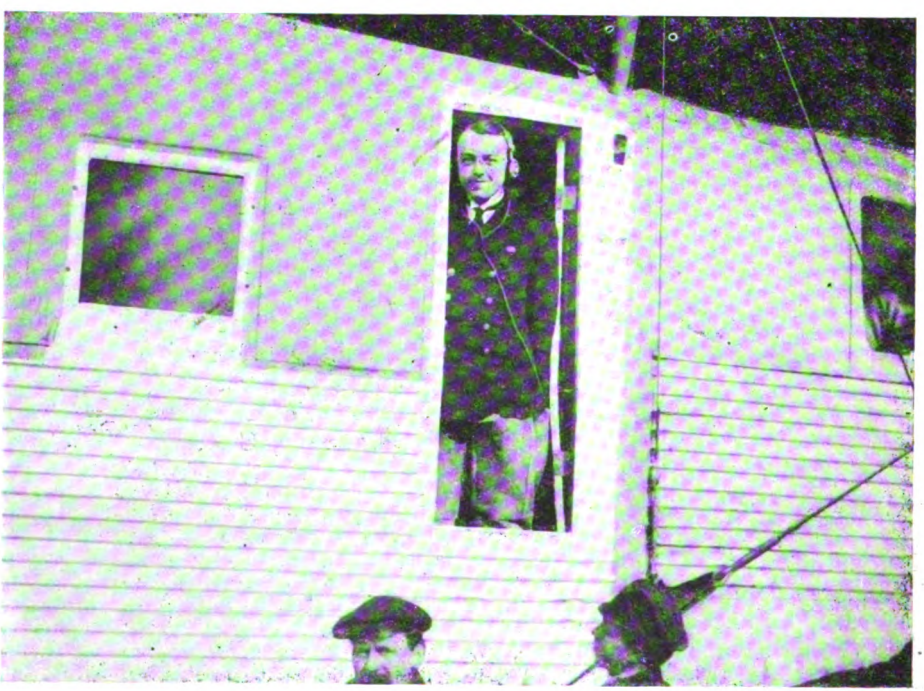

Photo Topical Press.

The wireless operator on R.34, the world's largest airship.

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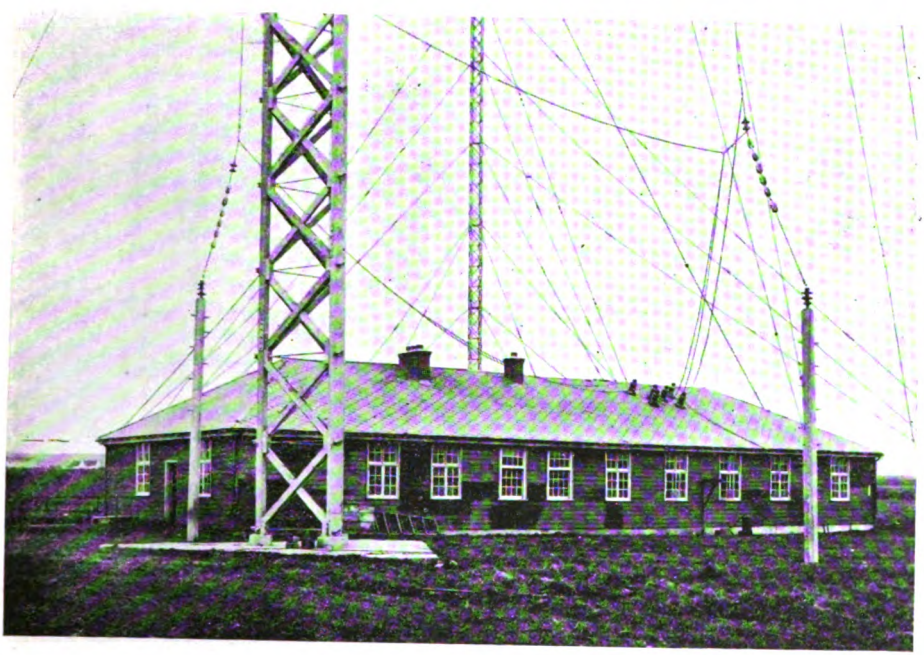
Transatlantic Wireless Telephony

AS stated in our April issue, wireless telephonic communication was established for the first time between Ireland and America in March last, and we are now able to give particulars of this most interesting and important experiment.

The objects of the test were to prove that with a combination of the oscillating valve transmitter and the modern Marconi type of valve receiver only quite a small amount of power is required to transmit either telegraphic or telephonic messages across the Atlantic, and also to obtain some data as to what power would be required, using these modern methods, for continuous commercial operation over such a range. Both objects were successfully attained.

In these experiments communication was attempted in one direction only, the sending apparatus being installed at Ballybunion, Co. Kerry, Ireland, and the receiver at Louisburg, Cape Breton, Nova Scotia.

At Ballybunion a portable petrol motor was used as prime mover to drive an electric generator, which supplied approximately 2.5 kilowatts at 12,000 volts to the oscillating valves. The valves employed were of the pattern designed by the Marconi Company, and known as Type M.T.1, and two of



Ballybunion Wireless Station.

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these were used in parallel as oscillation generators. For speech transmission a third valve was used to vary the input to the oscillators in accordance with the microphone currents produced by the voice.

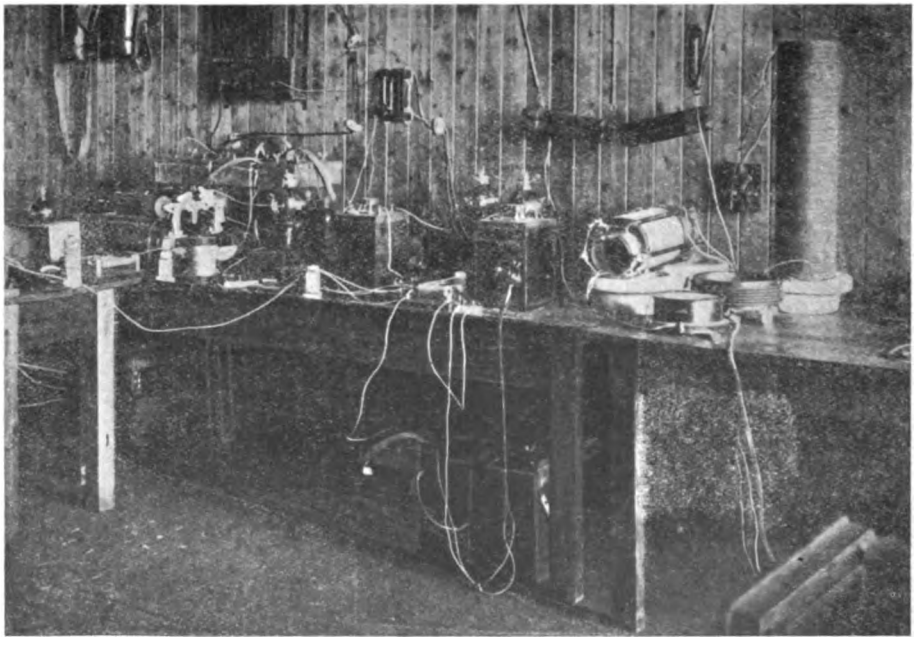
With the power input above stated, the aerial current registered was sixteen amperes at a wave length of 3,800 metres.

The aerial was of umbrella form supported at the centre by a mast 500 feet in height. At the receiving station in Louisburg a Type 55 receiver was installed. As our readers will probably remember, this type of receiver was illustrated and described in the March issue of THE WIRELESS WORLD. After a few preliminary tests to London and Chelmsford, a regular daily programme extending over ten or twelve days was sent from Ballybunion, all these programmes being duly received at Louisburg. At this distance of 1,800 miles the speech was of sufficient strength to be easily understood, provided interference from spark stations was not too great.

It is interesting to note that the strength of speech from Ballybunion at Chelmsford, about 500 miles away, was such that the signals were clearly audible on a "frame" aerial only six feet square, using the Type 55 receiver.

Besides speech, continuous wave Morse signals were also transmitted from Ballybunion, and these signals were reported as "strong" at Louisburg.

As the tests proceeded it was recognized that to obtain reliable telephonic communication over the range through any probable interference, increased power was desirable, and as a more powerful engine was not immediately



The transmitting apparatus by means of which Wireless Telephony between Ballybunion (Ireland) and Nova Scotia was accomplished.

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available, the experiments were temporarily discontinued. It should be clearly recognized that there was nothing in the nature of a "freak" in connection with these tests. Every programme over the whole period of the trials was received, and the whole of the transmission was done during hours of daylight, generally between 10 a.m. and 1 p.m. G.M.T. As these experiments mark a definite stepping stone in the history of wireless communication, we take this opportunity of placing on record the names of the engineers who were directly concerned in successfully carrying out the tests. These were Mr. W. T. Ditcham, who was responsible for designing and installing the transmitting circuits at Ballybunion, and Mr. W. J. Picken, who was in charge of the receiving apparatus at Louisburg.

THE TRANSMISSION OF SPEECH BY LIGHT.

A PAPER on the above subject was read by Dr. A. O. Rankine before the Physical Society of London on May 9th, describing the results of experiments carried out at University College, London, at the request of the Admiralty Board of Invention and Research.

The paper was concerned chiefly with the manner in which it is possible to produce a beam of light fluctuating in accordance with speech sounds. The electrical conductivity of a selenium cell varies with the intensity of the light falling on it, so that by connecting the cell in series with a battery and a telephone receiver, the fluctuating beam of light from the transmitter can be reconverted back into sound waves. At the transmitter two main possibilities are open; to control the source of light by the speech or to effect the control of the beam from a steady source. For the latter method the speech is caused to interrupt the light with the proper periodicity and amplitude, *after* it has left the source.

In the experiments described, the sun was generally used as source of light, although an arc lamp was sometimes employed. The method consists in interposing a fixed grid into the beam of light to cut it up into narrow bands. The grid is mounted close upon a lens which focusses the source upon a small concave mirror. This mirror is attached to a small lever controlled by the diaphragm of a phonograph sound-box, into the trumpet of which the speaker's voice is directed. The beam of light from this mirror is directed through a second lens and grid system, similar to the first, and thence on to the receiving station. When sound waves fall on the diaphragm the small mirror is thrown into vibration. This causes the image of the first grid to move about over the second grid. When the dark and light bands of this image coincide with the bars and spaces of the second grid the maximum strength of light beam passes to the receiver. When, however, the vibration of the mirror caused by the speaker's voice causes the image to move, the amount of light passing through the second grid will be correspondingly varied, since the grid and image no longer coincide.

In the present form of the apparatus lenses (and grids) about 7 inches diameter are employed, and the bars and spaces of the grids are each $\frac{1}{10}$" wide. A speaking range of $1\frac{1}{2}$ miles has been easily covered, while the articulation at the receiver is remarkably good.

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Field Wireless Telephony and Direction-Finding.

An Account of a recent successful Demonstration.

ON May 27th a very interesting demonstration of wireless telephony and direction-finding by wireless was given by Marconi's Wireless Telegraph Co. Ltd., to representatives of the Press, the apparatus employed being that which has been specially designed for pack or wheeled transport. At Broomfield, a village near the Marconi Works at Chelmsford, a field wireless telephone was erected, consisting of a standard set arranged as a combined telephone and telegraph station. The guaranteed range of this apparatus for telephony is 60 miles over normal flat country; for telegraphy by the "tonic train" method 100 miles, and for telegraphy by C.W. transmission 200 miles. Under favourable circumstances all these ranges can be approximately doubled. The whole station can be erected in 10 minutes by six men, though it is possible for two men to erect and work it. The masts are of steel, 30 feet high and support a single horizontal aerial, and the "earth" simply consists of metal gauze laid directly on the ground. The prime mover (Fig. 1 left hand) is a two-

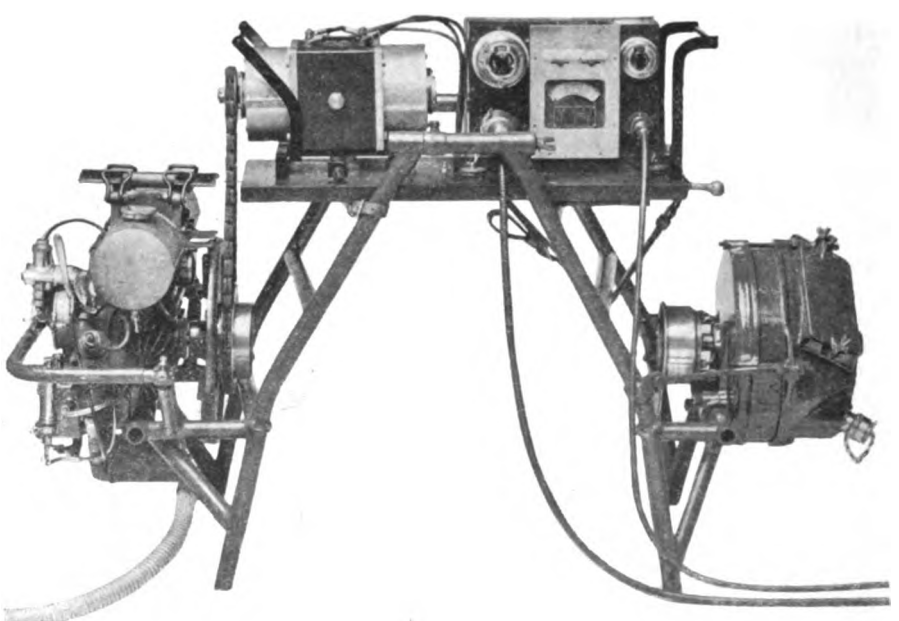

Fig. 1.

The pack set arranged for charging accumulators.

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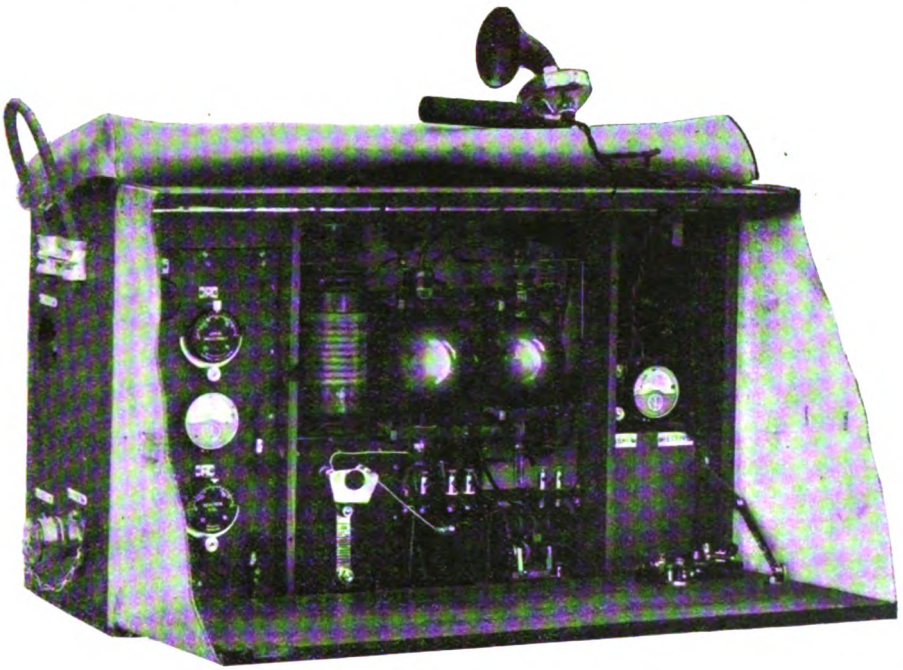

Fig. 2.
The portable wireless telephone transmitter.

cylinder $2\frac{3}{4}$ h.p. petrol engine, and drives a high-frequency $\frac{1}{2}$-kilowatt alternator (Fig. 1 right hand) which is completely enclosed as a protection from adverse weather conditions. The power generated by this alternator is led to the transmitting circuits by armoured connectors, where it passes through the transformers, one of which steps up the potential from 100 volts to 10,000 volts, the current then being rectified to direct current by a Fleming valve for the purpose of feeding the main transmitting valve (Fig. 2). Another transformer steps the E.M.F. down to 8 or 10 volts and supplies the filament of the Fleming valve, whilst a third supplies the filament of the main transmitting valve. Connection from the alternator to the various transformers is controlled by the main change-over (transmitting to receiving) switch, which at the same time connects the aerial either to the transmitter or receiver.

The receiver (Fig. 3) consists of a simple tuning device connected to the aerial by a change-over switch. The received currents are amplified by a series of 3-electrode valves, the last of which rectifies them and feeds the telephones through a transformer. The filaments of the receiving valves are heated by current supplied by a 6-volt accumulator battery, and the "high tension" circuits (filament-plate circuits) are fed by a 20-volt. battery (see Fig. 4). The accumulator charging dynamo with switchboard and cut-outs is shown in Fig. 1.

By means of this installation telephonic communication with Marconi House, London, was obtained and the Mayor of Chelmsford held speech with

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Mr. Godfrey Isaacs. Several representatives of the Press also conversed with London and satisfied themselves that the quality of speech attained was much better than the ordinary "wired" variety. Whilst this demonstration was taking place another party of visitors, including the Mayor of Colchester, proceeded by motor-bus towards Colchester. They took with them in the bus a complete telephone receiving set and were able to hear conversation and gramophone music which was being transmitted from Chelmsford. When this party was some 10 miles distant from Chelmsford a lorry containing a portable wireless station was pushing ahead with sealed orders from the Mayor of Colchester as to where the apparatus was to be erected. The object in view was to demonstrate the accuracy with which wireless direction-finding plant can locate wireless stations and to this end two direction-finders had been previously erected, one at Braintree and the other at Malden. In due course the lorry reached the spot designated in the sealed orders; here the apparatus was set up and signals were transmitted for the benefit of the direction-finders. Within a few minutes the necessary observations had been made and notified by wireless telephony to Broomfield, where the calculated position of the lorry was marked on the map, and communicated by wireless telephone to the Mayor of Colchester, who replied to the effect that the direction-finding apparatus had succeeded in locating the spot to which he had directed the lorry.

The value of this method of ascertaining the bearings of wireless stations cannot be over-estimated, and for purposes of navigation, both marine and aerial, a direction-finding set is undoubtedly destined to become generally adopted. The apparatus used for the demonstration is shown in the accompanying illustration, and is of the Marconi-Bellini-Tosi type. It consists electrically of two main parts, the aerial

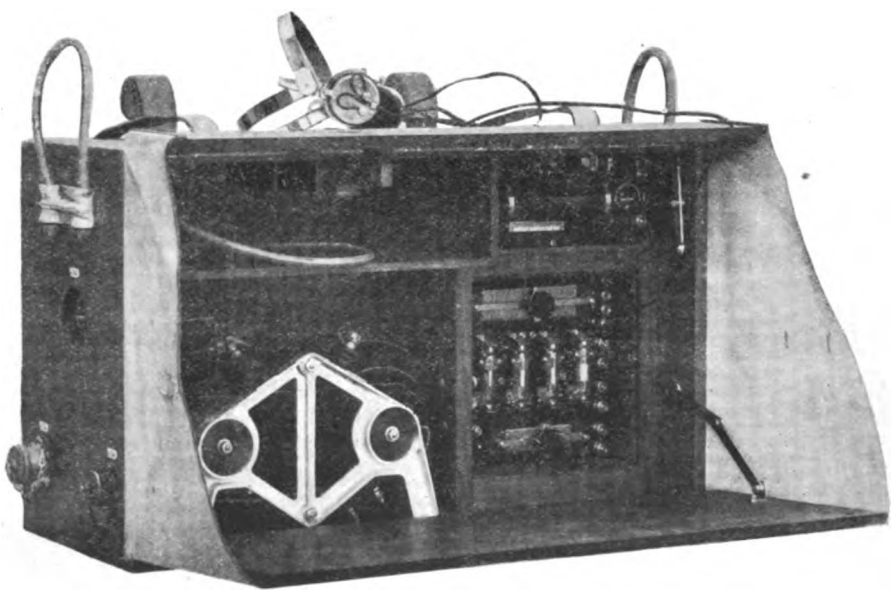

Fig. 3.
The portable wireless telephone receiver.

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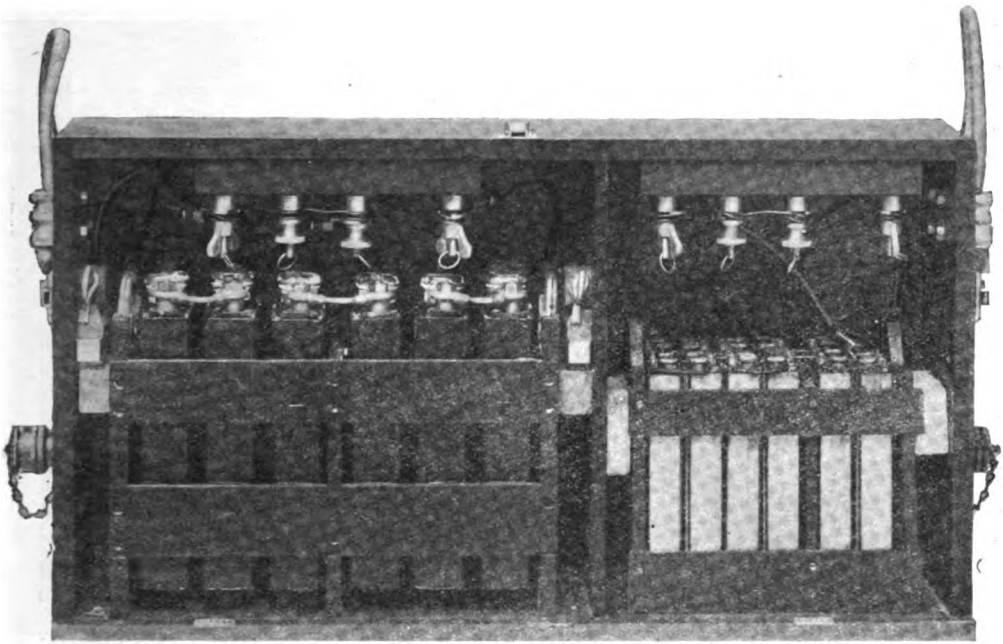

Fig. 4.
The accumulator batteries for the receiver.

circuits and the detecting circuits, the aerial system comprising two closed oscillatory circuits insulated from each other and from the earth. Each of these oscillatory circuits consists of an aerial loop in series with which are a coil of wire and a condenser, the latter being inserted in the middle of a coil, for symmetry. The two aerial loops, which are of equal size, are suspended in vertical planes crossing each other at right angles. The two coils of wire are also of equal size and also cross each other at right angles in vertical planes. Inside these crossed coils a third coil, called the exploring coil, is mounted on a vertical spindle by means of which it can be set at various angles with reference to the fixed coils. Each aerial loop is a directional aerial which receives best when its plane is in the direction of the sending station, and if its plane is at right angles to the direction from which the signals are coming it receives nothing. In intermediate positions it receives signals, the induced current due to which varies as the cosine of the angle between the plane of the aerial loop and the direction of the sending station. Except in the case when one of the aerials is in a plane exactly at right angles to the direction from which signals are coming currents are induced in both aerials, their relative strength depending on the direction of the sending station with reference to the planes of the two aerial loops. These currents pass through the corresponding crossed coils in the direction-finding instruments and produce in the space enclosed by them two magnetic fields at right angles to each other. The two fields, whose relative strength depends on the relative strength of the currents induced in the two aerials, combine to form a resultant field at right angles to

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Photo. Topical Press Agency.

The Mayor of Colchester and Captain H. R. Sankey on the omnibus. Note the "frame" aerial.

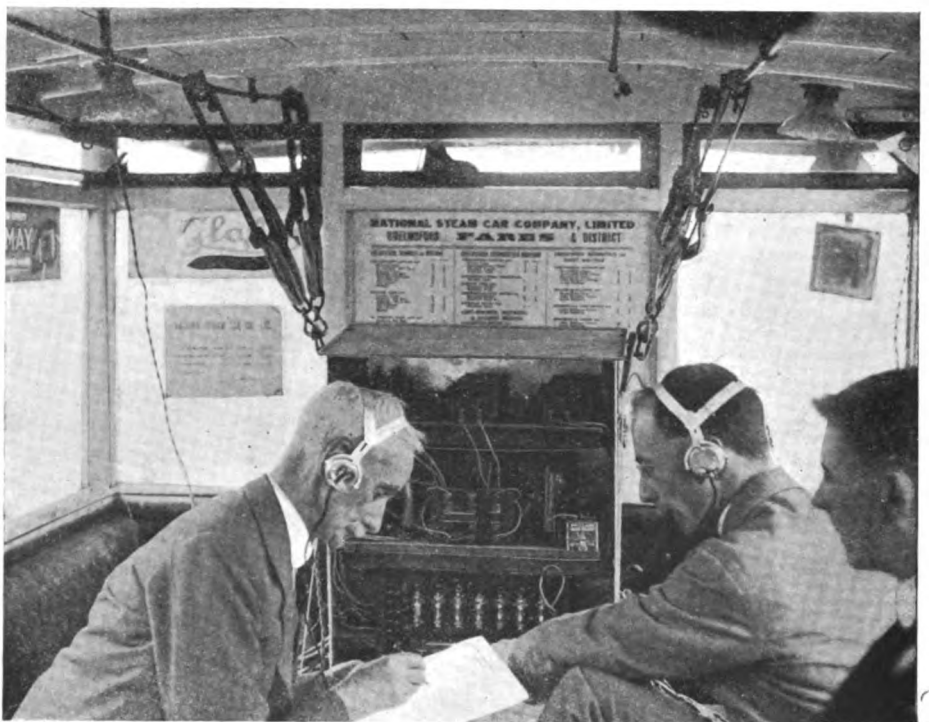

Photo Topical Press Agency.

Inside the omnibus. The Town Clerk of Colchester receiving a message.

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the direction at which signals are coming. Consequently the exploring coil will receive the strongest signals when its plane is at right angles to that of the resultant field, that is to say, when its plane is in the direction from which signals are coming. A pointer attached to the spindle on which the exploring coil is mounted indicates the position of the latter, and consequently the direction of the sending station.

The detecting apparatus consists of the usual tuning arrangements and a super-sensitive seven-valve receiver, similar to that which was described in the February number of the WIRELESS WORLD. This amplifier consists generally of a series of 3-electrode valves linked together by transformers. The valves amplify the high-frequency oscillations received in the aerial circuit, the last one being arranged as a rectifier. This instrument is designed for use on comparatively short wavelengths, the approximate limits being 3,000 metres for spark reception and 10,000 metres for continuous wave reception.

The bearings taken with this direction-finding apparatus probably do not exceed in accuracy those taken with a good optical instrument under favourable conditions, yet reliable bearings may be taken with it when direct bearings cannot be taken owing to bad weather or other causes. Under fairly good conditions bearings may be taken within two or three degrees, the accuracy of the results obtained depending almost entirely on the care with which the observations are made, the error due to the instrument itself not exceeding one degree. It is not necessary to "swing ship" in order to take bearings, and deviation owing to the iron work of the ship is practically non-existent unless the conditions are exceptionally un-

One of the Direction-Finding Stations described in the accompanying article.

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favourable. The range of the set is from about 10 to 50 miles depending on the power of the wireless station from which signals are being received or upon the size of the aerial which is available.

By means of this system ships at sea or aircraft in flight will be enabled to obtain their positions during fog or bad weather from coastal or aerodrome stations. Another application of the direction-finder is to find out whether a ship is on a course which will take it inside or outside lightship or isolated lighthouse; similarly when making a harbour a few signals from a station in the harbour will show at once if the ship has drifted to one side of the entrance.

On May 28th a similar demonstration was given to the representatives of the technical press, and Sir Joseph Ward, Premier of New Zealand, spoke by wireless telephony to Chelmsford from Marconi House. The demonstration was repeated again on the following day in the presence of various military attachés, army and navy officers and other officials.

FACILITIES FOR DIRECTION-FINDING AT SEA.

AN important new Notice to Mariners (No. 1019 of the year 1919) has been issued by the Admiralty concerning wireless direction-finding, and the arrangements which have been made for ships to avail themselves of this means of ascertaining their bearings. The methods of asking for and giving bearings and the waves to be used will shortly be standardised by International agreement; and the particulars of the D.F. stations will eventually appear in the International list of Radiotelegraph stations. Meanwhile each country is publishing regulations governing the use of its own D.F. stations.

There are two principal systems of D.F. stations at present in use, viz.:—

(a) Where each D.F. station is fitted with transmitting and receiving gear and works independently of others.

(b) Where several D.F. stations (all of them usually near a harbour entrance or difficult passage) are linked together by special land telegraph lines, being thus controlled by one station which alone is fitted with transmitting apparatus. The controlling station in such cases is not necessarily a D.F. station, but may be an ordinary coast station.

Lists of existing D.F. stations in Canada, Newfoundland, the United States and the United Kingdom are given, with details of call signals, range, longitude, latitude, and the wavelength employed.

Full instructions governing the methods which should be followed by ship stations when requesting bearings are also given, together with the manner in which the various coast stations will reply and comply. It is of importance to note that D.F. stations in the United Kingdom keep watch and take bearings on the 450 metres wave, and that ships with Marconi apparatus can adjust their transmitting gear very nearly to this wave (using reduced power) by cutting out half the primary transmitting condenser and adjusting the A.T.I. till the earth lamp shows maximum current in the aerial. The primary slider should be "all in."

The Notice concludes with a list of the charts affected.

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Notes of the Month

GENERAL FERRIÉ.

GENERAL Ferrié, C.M.G., LL.D., Technical Director of the French Wireless Service, occupied the place of honour at a complimentary dinner given at Princes' Restaurant on Monday, May 12th, by the members of the Council and of the Wireless Committee of the Institution of Electrical Engineers.

In addition to the General, the company included Mr. C. H. Wordingham, C.B.E., President of the Institution, in the chair; Major E. A. Barker, Mr. Charles Bright, Mr. W. R. Cooper, Dr. W. H. Eccles, Major J. Erskine-Murray, Lieut.-Col. W. Ll. Evans, Mr. Andrew Gray, Prof. G. W. O. Howe, Mr. J. S. Highfield, Capt. J. K. Im Thurn, Mr. W. Judd, Mr. J. E. Kingsbury, Prof. E. W. Marchant, Sir Henry Norman, Sir Richard Paget, Mr. C. C. Paterson, Mr. W. R. Rawlings, Mr. P. F. Rowell, Capt. H. Riall Sankey, Mr. E. H. Shaughnessy, Capt. Slee, Mr. Roger T. Smith, Mr. A. C. C. Swinton, Mr. J. E. Taylor, Mr. R. H. Tree, Lieut.-Col. A. D. Warrington-Morris, and Capt. S. Vokota.

The toasts of H.M. the King and the President of the French Republic having been honoured, the Chairman proposed the health of the guest of the evening, and was followed by Dr. Eccles. In his reply, General Ferrié gave an interesting account of the great part played by wireless telegraphy in the war.

W/T. IN CHINA.

The Marconi Company have signed a contract with the Chinese Government whereby both parties agree to form the "Chinese National Wireless Co." with a capital of £700,000, each party subscribing half this amount, for the purpose of setting up factories for the maintenance of wireless equipment. Shanghai will probably be the location of the main factories, with auxiliaries at Pekin or Tientsin. The Government will grant a special charter to the Company, which is assured of a successful future. In view of the bad general state of the Chinese telegraph system, it is believed that there is a splendid opening for the development of wireless in China.

THE NEW WIRELESS TELEGRAPHY BILL.

The text has recently been issued of Lord Somerleyton's Merchant Shipping (Wireless Telegraphy) Bill. The Bill provides that every British passenger steamer, or a ship of 1,600 gross tonnage or upwards shall be fitted with wireless telegraphic apparatus, shall maintain a wireless service of a nature to be prescribed by the Board of Trade, and shall carry one or more certificated operators. Where it is considered that the provision of the apparatus is unnecessary or unreasonable, the Board of Trade may exempt certain ships or classes of ships. A clause of the Defence of the Realm Act rendered it compulsory for vessels of over 1,600 tons gross to carry wireless for the duration of the war, and the new Bill seeks to perpetuate this.

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AMATEUR WIRELESS IN AMERICA.

The war time restrictions on amateur, technical and experimental receiving stations in the U.S.A. have been removed, and those on sending stations are expected to disappear before long. As a result, the market for small wireless sets has opened and the buying has already become large. The ranks of amateurs are now augmented by numbers of men who became acquainted with radio work whilst on service, and with the air and ground requirements in connection with flying steadily increasing, there promises to be a heavy demand for wireless apparatus. It is of interest to note that in 1914 the sale of this class of material amounted, in round figures, to $672,600.

AMATEUR WIRELESS IN GREAT BRITAIN. A WARNING.

On May 13th at Sutton Coldfield, Mr. H. P. Frazier was fined £25 and £3 3s., advocate's fee, for having in his possession, without the written permission of the Postmaster-General, an apparatus for the reception of messages by wireless telegraphy. We would draw the attention of amateur wireless men, or rather, of all our readers, to Section 22 of D.O.R.A., and point out that *it is still in force* up to the time of our going to press. Without the Postmaster-General's permission one may neither harbour wireless apparatus, nor traffic in it.

WIRELESS CLUB NOTES.

The Three Towns Wireless Club of Plymouth is in full swing. The meetings of May 1st and 7th were devoted to instructional purposes. On May 21st, Mr. Voss described his wireless experiences in the R.F.C. and on May 28th he lectured on the subject of valve receivers and transmitters. The Hon. Sec., Mr. W. Rose, announces that it has been decided to make Plymouth the headquarters for amateur clubs in Devon and Cornwall, and to hold an annual exhibition of wireless apparatus.

The North Middlesex Wireless Club held its 18th meeting (the first since the war began) at the Village Hall, Old Southgate, on May 21st. The Chairman, Mr. A. G. Arthur, welcomed the old members and congratulated many upon their safe return to civil life. He referred also to the great loss sustained by the club, through the death while on active service, of Mr. R. A. P. Davison their Treasurer. Mr. Savage, the Secretary, then set forth the condition of the club, financial and otherwise, and stated that he hoped to arrange future meetings at the club's old home at Shaftesbury Hall, Bowes Park. Next, Lieut. L. G. Holton gave a lecture on valve receivers, which was enthusiastically followed by those present. Full particulars of the club may be obtained from the Hon. Secretary, Mr. E. M. Savage, "Nithsdale," Everley Park Road, N.21.

It is proposed to form a Wireless Society for Sheffield and district. Those desirous of joining should communicate with Mr. L. H. Crowther, 156 Meadow Head, Norton Woodseats, Sheffield.

The Leicestershire Wireless Society, which practically ceased to exist during the war, is being revived under the name of the Leicestershire Radio Society. Messrs W. J. Rowlett and P. Holyhead have been appointed hon. secretary and hon. treasurer respectively. The chief object of the Society is to assist amateurs to study wireless in all its branches, and with the coming of peace it is anticipated that good, practical work will be accomplished.

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Correspondence

THE AMATEUR POSITION.

THE amount of interest which is being evinced in what has come to be termed the "amateur position" is astonishing. So many kind enquiries and eager interrogations reach us by mail and telephone that we feel more than ever assured that we are but voicing the just and reasonable claims of a very considerable body of citizens when we ask those in whom the public has vested its authority to take the shackles from wireless enthusiasts, to return to them their property and give them leave and licence to use it. We are fully aware of the new technical difficulties which have arisen as a result of the wartime development of new methods and apparatus, and which now confront the authorities who are considering the question of amateur wireless working; they can be summed up in one word—valves. That a return to crystal reception and spark transmission will in due time be permitted we have little or no doubt. *Already the Postmaster-General has signified his readiness to issue licences for the reception of time signals by clockmakers in connection with their business.* Nevertheless, those who are familiar with the use of ionic valves well know that carelessness in or ignorance of their manipulation may lead to much more serious "jamming" than is likely to occur with a spark transmitter if the wavelength and power specified in its licence are not exceeded. A denial of all facilities for valve work would be a heavy blow to amateurs because their interest in these inventions has risen to a degree such as we have never seen equalled in connection with any other instrument used in wireless telegraphy. We again reiterate our firm belief that once the Peace Treaty is signed the authorities will announce and bring into force their decisions concerning this very important national question, and that amateurs will be reinstated. But we hesitate before arousing hopes in regard to the use of continuous waves by amateurs.

The following letter from a correspondent who desires to remain anonymous is typical of many we have received:—

"DEAR SIR,

"I have followed with much interest your articles in the WIRELESS WORLD, *re* the position of the amateur. I quite agree with all the arguments brought forward in favour of the continuance of the amateur, and think it would be highly unjust, and a bad policy, if the Government prohibited experimenting in this direction, and also in many cases an ungrateful return for services rendered.

"I had a very efficient station for some time preceding the war. Part of my apparatus was used in a local Fort, and I was responsible for teaching wireless to a youth who gave his services to the Army in this work. I was too old myself to do the same. I was also responsible for carrying out experiments in wireless signalling on the examination vessels in the Mersey prior to the war.

"Needless to say, I am very anxious to re-start. If there is any information or advice that you can give me I shall be much obliged."

A most interesting letter has been received from Mr. John M. Clayton, of 1301 Welch St., Little Rock, Arkansas, who describes some of the work of amateurs during their last "season." It seems that transmission by amateurs over a distance of 2,000 miles is by no means rare, and he looks forward to working with an English confrère. Mr. Clayton assures us that the whole fraternity "over there" is watching with interest the outcome of the pro-amateur agitation in this country, and is anxious to get into touch with someone who will write concerning the pre-war work of English amateurs. Will the wireless clubs kindly take note of this?

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The Weagant "X-Stopper."

(Continued from June Number.)

THE need for the spacing of the two loop aerials comprising this special type of receiver can be made evident by an examination of the diagrammatic sketch of Fig. 5.

The two closed loop aerials A and B are shown coupled to the common radio-goniometer coils L_6 L_6 by means of the inductances, L_5 L_7 as in Fig. 4. The extra tuning coils L_1 L_2 L_3 L_4 are omitted for simplicity. The direction of the incoming signal wave is represented by the arrows, and the supposed direction of propagation of X impulses by the arrows X X.

Assuming, in the first place, that the two loops are spaced one and half wave-length apart between their centres, then at some given instant the signal wave may be represented by some such curve as D.E.F.G.H. It is at once evident that the space occupied by either of the loop aerials is covered entirely by one complete half-wave of the signal, and that when the negative half-wave is covering one of the loops, the positive half-wave will cover the other. This being the case the current induced in loop A by the signal wave, will at any given instant be opposite in direction to that set up in loop B, hence their effects upon the common secondary circuit L_6 C_2 may be made additive by reversing one set of coils, L_5 or L_7.

On the other hand, the wave carrying the X impulse in the direction indicated by the vertical arrows, will reach both loops simultaneously, so that the resulting currents set up in these loops will at any given instant be in the same direction in both loops. Hence,

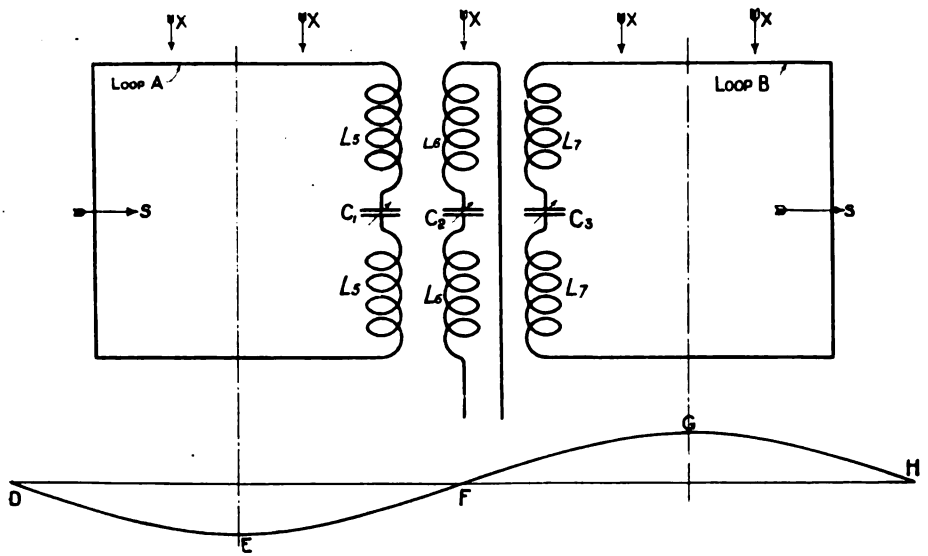

Fig. 5.

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owing to the reversal of one of the set of coils (necessary as mentioned above to secure addition of the two signal currents) these two X impulse currents will cancel out and produce no effect upon the receiver connected to the secondary C_2 L_6. Hence the signal will be heard with approximately twice the strength that would be obtained with a single loop, while the "X" will be nearly, if not quite eliminated.

It remains now to consider what will be the effect upon the signal of altering the spacing of the loops, or what amounts to the same thing, of using a given pair of loops with signals of various wavelengths. This matter is of considerable importance in connection with the practical application of the method, since it would obviously be impractical to instal a large number of such aerial systems at different loop spacings in order to enable one given station to receive from several other transmitting stations. In the case of many stations it would also be extremely inconvenient to employ aerial systems stretching out over such long distances. Take for example the case of reception of a long-distance station using a wavelength of 15,000 metres. The half-wavelength "loop spacing" necessary for this would be 7,500 metres, but as may be seen from Fig. 5 the extreme parts of the loops stretch to almost one whole wavelength apart—i.e., in this case 15,000 metres, or say at least $9\frac{1}{4}$ miles for the necessary extent of the station grounds. Hence the most likely condition to arise in practice is a loop-spacing of *less* than one half wavelength.

Referring again to Fig. 5, it is to be expected that if the loop spacing is reduced relative to the wavelength, the resultant signal intensity would also be reduced. The simplest way of illustrating this effect is by means of a vector diagram—Fig. 6.

OV_1 represents the voltage induced in one loop—e.g., A—and OV_2, the corresponding voltage in the second loop B.

In the case where the mean loop spacing $= \frac{1}{2}$ wavelength, there will be a phase difference of 180° between these two voltages. This is represented in the diagram by drawing OV_1 and OV_2 at an angle of 180°. Since one coupling coil is reversed the effect on the secondary circuit will be the vector difference of V_1 and V_2. In this case this becomes the algebraic sum, and is represented by O V = where the voltage $V = V_1 = V_2 = 2V_1$. Suppose now that the loop-spacing is reduced to 1/3rd. wavelength. The electrical phase difference between the two induced voltages will now be 120° This condition is shown in Fig. 7.

Fig. 6.

The resultant voltage is the vector difference of OV_1 and OV_2, and is shown as the vector OV in the diagram. In this case $V = 1 \cdot 173 \times V_1$.

Similarly when the loops are $\frac{1}{4}$ wavelength apart the resultant induced voltage V becomes $= 1 \cdot 41 \times V_1$; when 1/6th wavelength apart, $V = 1 \times V_1$ at 1/10th wavelength, $V = 0 \cdot 62$ V_1; (Fig. 8) and so on.

It should be noted that the resultant induced voltage steadily diminishes as the loop spacing is reduced, but that it does not disappear as long as there is any appreciable spacing at all between the two loops.

The balance of the two loops for the X-interference remains unaffected by the change of loop spacing relative to wavelength, so that it becomes possible to amplify the reduced signal strength

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consequent upon a small loop spacing and yet not to amplify up the atmospheric interference to the same extent as would be the case if no "X-stopping" arrangement were in use.

As an example of what may be accomplished in practice the folowing results may be quoted:—

Using a loop spacing of 5,000 feet, and receiving from Nauen on 6,000 metres, the resultant signal was approximately 40 per cent. greater than that due to either aerial alone; this case corresponds to a loop spacing of approximately $\frac{1}{4}$ wavelength.

When receiving from Carnarvon on 14,200 metres, the loop spacing becomes approximately 1/9th the wavelength, and the resultant signals were materially weaker than when receiving on one loop, but the troublesome atmospheric noises were eliminated.

To carry the loop spacing reduction still further, it is easy to calculate the resultant signal strength with, say, a loop spacing of 100 ft. and a wavelength of 3,000 metres. Using the vector diagram method of Figs. 7 and 8, it is found that the resultant signal

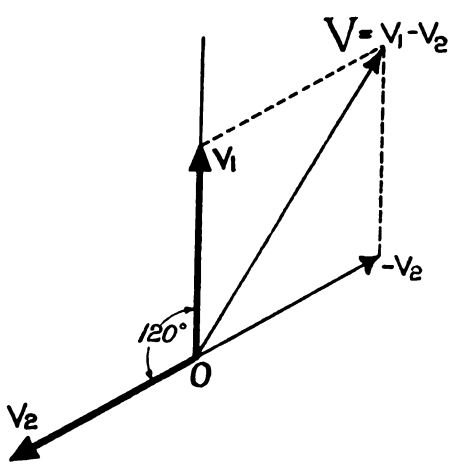

Fig. 7.

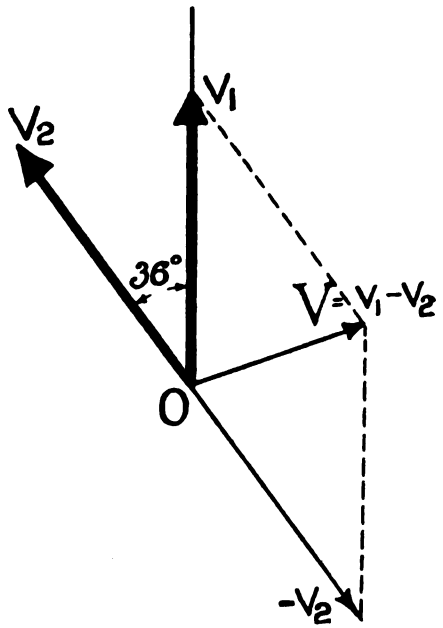

Fig. 8.

strength = 0.0639 × the strength received on a single coil. Hence merely a 16-fold amplification could restore this signal to normal strength while retaining the full advantages of the X-balance.

This reduces the size of the apparatus to much more practical limits, and would probably render it more suitable for use in many cases where the full-sized aerial loop spacing would be impracticable.

Such a reduced aerial system might be within practical possibility for use on shipboard, but if fixed would necessitate turning the ship in line with the incoming waves.

By the addition of a third receiving loop it becomes possible to secure a somewhat more perfect balancing out of atmospherics—including as well the "clicks" which have in general a more localised horizontal direction of propagation than the "grinders" which as has been shown are generally propagated in a vertical direction.

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Wireless in Northern Russia

WITH THE BRITISH EXPEDITIONARY FORCE.

By a Wireless Officer.

THE system of wireless inter - communication as now established by the War Office in North Russia is one of the most complete and efficient that the writer has during an experience of some seventeen years been privileged to be associated with.

Early in 1918 a small force of Allied troops was landed on the bleak and uninviting Murman coast. The reasons for this landing are well known to the public, but only a few of us have any conception of the many difficulties—diplomatic and otherwise—that had to be dealt with by the General Officer Commanding and his Staff.

The writer's duty was to ascertain the possibilities for wireless working, both as a means of local inter-communication and for communicating with England direct, and in a future article it is hoped that the many unique experiences encountered may be related.

There are at present four chief stations, namely, Murmansk, Archangel, Kandalaksha and Kem, each of which communicates with, controls, and supplies press messages to a number of outpost stations.

At this point the writer would like to relate how he succeeded in establishing communication (both ways) with an outpost some eighty miles from the base with an ordinary spark Marconi pack set.

The author and staff at Kem. Twenty degrees below zero!

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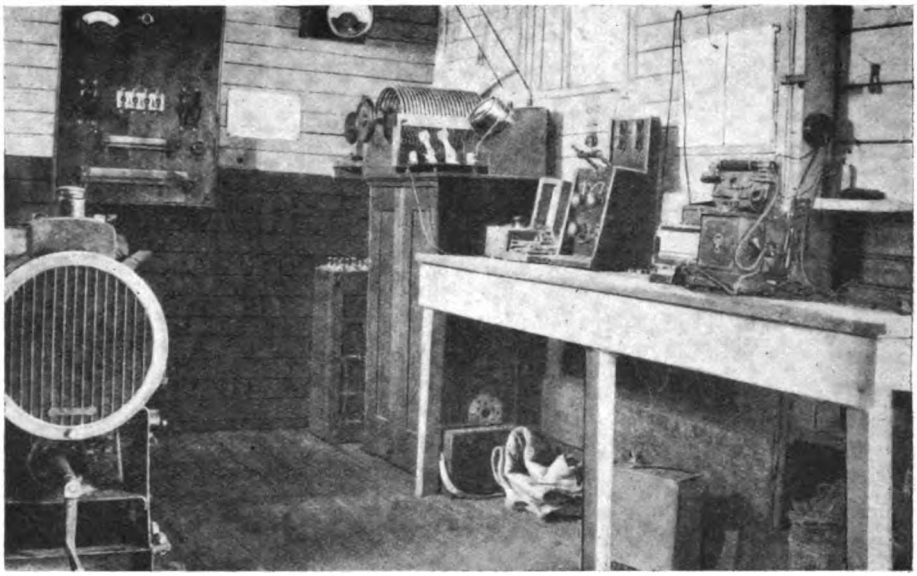

Kem Wireless Station, showing 3-k.w. spark set. This station is also fitted with a 250-watt C.W. valve set.

This set was only rated for thirty miles; however, the writer with vivid and painful recollections of earlier days, when one's sleep was haunted by visions of coherers, magnetic detectors and Poldhu low-frequency sparks, had taken himself strongly to think before making the proposal. He had keen men, with the knowledge that in wireless, determination and enthusiasm are often more effective than the literal carrying out of instructions contained in the inevitable "book of words." The writer established not one but two pack sets at distances of between seventy to ninety miles away on lonely outposts which previously could only be communicated with by runners—a seven days' journey. Moreover, the intervening country is very mountainous. These stations are still in hourly use and the Headquarters Staffs would feel the loss of them very much indeed.

The principles upon which the writer worked are quite simple. At the base stations the output for transmission on spark is about 3 kilowatts—certainly more than enough to cover the required distance and to be heard with a carborundum potentiometer receiver at the pack station—while the receiver was a carborundum potentiometer with three valve amplification. It is sufficient to say that signals both ways have always been of maximum strength.

The stations at Kandalaksha and Kem are in closed railway trucks or Russian Teplushkas, suitably lined and heated for the very severe winter. During the past five or six months the main stations have been installed with the latest C.W. (continuous wave) apparatus. The transmitters are of the valve type and have an output of 250 watts with a transmitting range of about 600 miles over mountainous country. A very fine sustained musical note is heard in the receivers from these sets. The receivers are of quite new design and embody some unique features which

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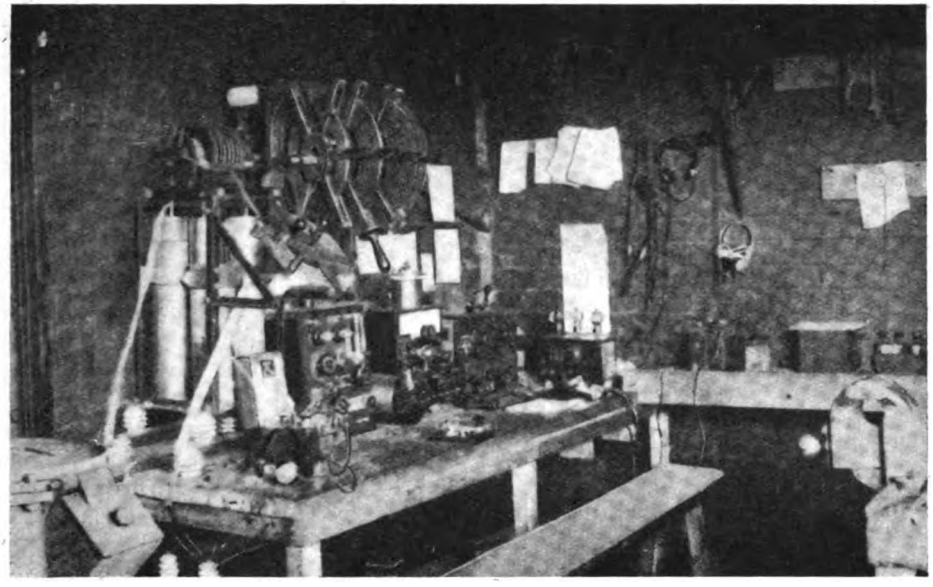
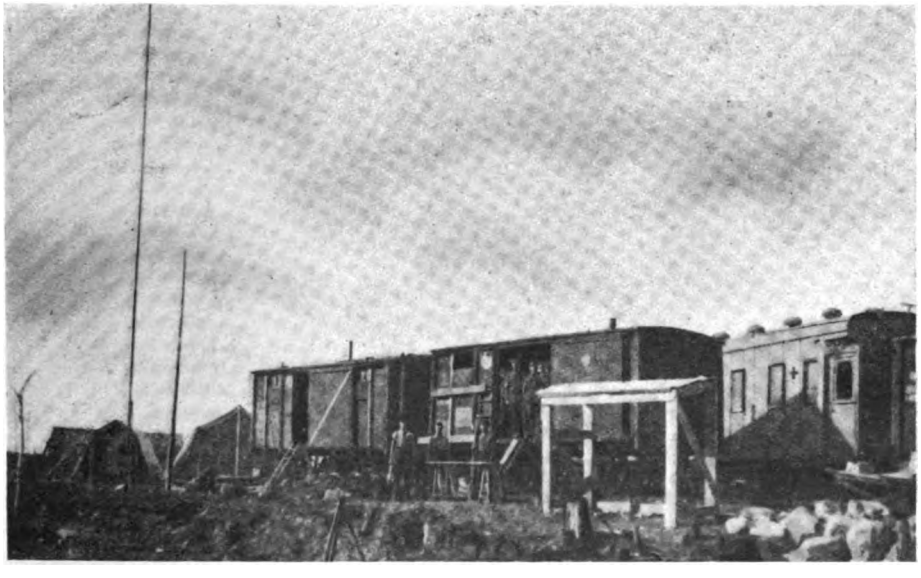


Kandalaksha Wireless Station, showing 2-kilowatt spark set.



Exterior of Kandalaksha Wireless Station. Note the telescopic masts.

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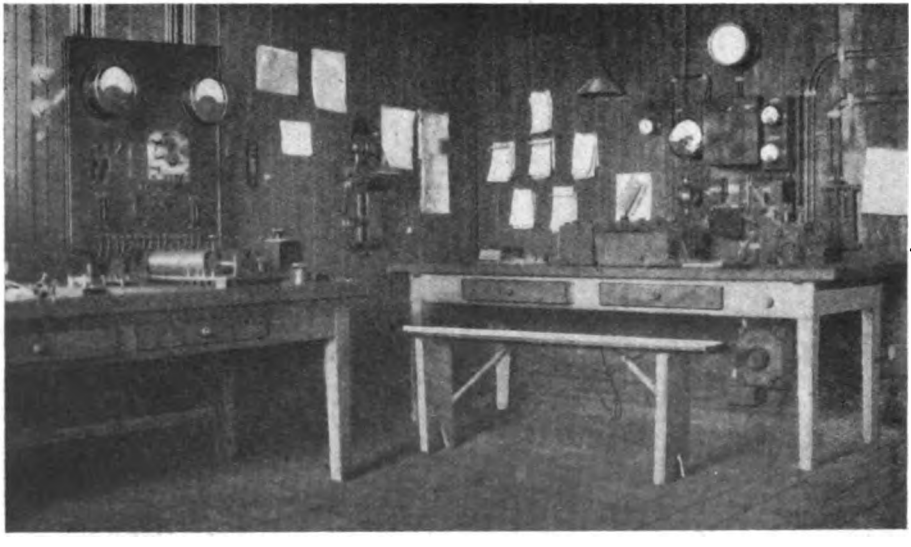
at a later date may be described in detail. The whole installation comprising the army type 250 watt set makes a very fine station and is a pleasure to operate by reason of its comparative simplicity, absolute reliability and wonderful efficiency. Amplifiers are, of course, part of the installation.

One of the greatest difficulties in the winter was the question of "earths." The Murman coast is, as the writer has suggested, rocky and mountainous, and does not, therefore, even in the summer, offer very good earthing facilities. In the winter months when the light soil is frozen hard, the question of using a ground earth is out of the question. So then at all our stations the counter capacity system is employed. Generally the lower capacity is greater than the aerial, but the writer, using a single strand T aerial and a single strand lower capacity of the same shape and length as the aerial, got practically the same results as with a larger lower capacity. In any case—so far as can be judged at present—a good counter capacity would appear to be equally as efficient and far more constant than the average "earth." The writer hopes to make further experiments in this direction during the next few months.

The photographs printed with this article will convey to readers some idea of the conditions and situations under which the wireless section of our Engineers work, among the ice in winter—and with the help of the mosquitoes in summer.

In conclusion the writer would like to note the great impetus—by reason of his interest, help and encouragement in the early days—given by General F. G. Marsh, C.M.G., C.B. (India Army), to the work of his Wireless Officer.



Interior of Murmansk Wireless Station. On the table under the switchboard at the left-hand is a long-wave C.W. receiver for the interception of American stations.

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Aircraft Wireless Section

Edited by J. J. Honan (late Lieutenant and Instructor, R.A.F.).

These articles are intended primarily to offer, as simply as possible, some useful information to those to whom wireless sets are but auxiliary "gadgets" in a wider sphere of activity. It is hoped, however, that they may also prove of interest to the wireless worker generally, as illustrating types of instruments that have been specially evolved to meet the specific needs of the Aviator.

AIRCRAFT WIRELESS SETS.

THE NO. 1 TRANSMITTER (STERLING)—(Continued).

MAINTENANCE.

IN order to maintain the set at maximum efficiency, a certain amount of care must be given to adjustable parts and other details, and it is proposed in this section to touch upon one or two points that will repay attention.

THE MAKE-AND-BREAK.

Perhaps the most important detail in this connection is the "break."

In the first place, it is by means of the break that the spark frequency is controlled, and thereby the pitch of the note in the receiving phones. Each break represents one breaking-down of the spark gap, the radiation of one wave train or series of damped high-frequency oscillations, and one "click" in the phones.

In the next place, the adjustment of the break affects both the amount of current flowing in the primary circuit, and also the value of the voltage induced across the ends of the secondary of the induction coil; both are important factors in the efficient working of the set.

If, for a given frequency, it can be arranged that the primary circuit is closed for a large proportion of the time elapsing between one break and the next, then the current has more time to "grow," and build up the magnetic flux passing through the core of the induction coil, thereby giving rise to a greater induced e.m.f. when the succeeding break does take place. For example, suppose a break took place once per second, and that the primary circuit remained unbroken for $\frac{9}{10}$ths of a second, the remaining $\frac{1}{10}$th being the time taken by the armature to swing away from the contact and back again, it is obvious that such an arrangement would be more advantageous in developing a high secondary e.m.f. than if the respective stages took each half a second.

Also it is evident that the sharper and more rapidly the "break away" from the primary is effected, the greater will be the induced voltage across the secondary, the value of which is determined by the time rate of magnetic flux variation.

In practice it is found that owing to imperfect contacting of the points at the higher frequencies, a larger value of primary current is usually obtained with a low note than with a high one. At the same time the general considerations previously set out hold good relatively for any frequency.

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THE STERLING BREAK.

The original Sterling break is illustrated diagrammatically in Fig. 8. It consists of a thin steel-blade armature fixed to a block at its lower end, and vibrating between two rubber buffers at the top. Slightly below the centre of the blade is the adjustable contact screw, which is held in position by a bridge-piece secured to the side of the box, and makes contact with a similar

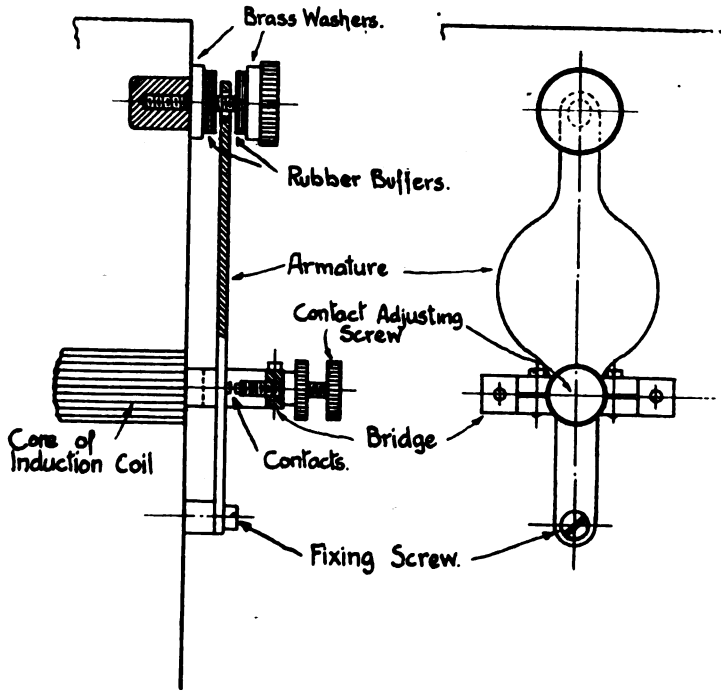

Fig. 8.

point secured to the armature. Both points are generally either of platinum or tungsten-steel. A platinum point should not be used in conjunction with a tungsten point as such a combination is likely to give rise to trouble owing to "sticking."

This type of break is controlled by means of the central adjusting-screw which fixes the distance between the two points.

The upper adjusting-screw which determines the swing of the blade away from and towards the core of the induction coil is usually fixed, the brass washers carrying the rubber springs or buffers being sweated on to the shank of the screw.

It will be found by experiment that this break has a natural note of its own at which it gives the most satisfactory results. The frequency of such note cannot be varied to any considerable extent without diminishing efficiency, so that it is somewhat inelastic in this respect.

Another disadvantage is that the break is not so rapid and sharp as in the type described in the next paragraph.

THE CLAPPER BREAK.

This break, which was eventually fitted to all No. 1 Service sets, is illustrated diagrammatically in Fig. 9. Its principal advantage is in the method

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adopted for securing a rapid "break away."

The armature in this case is of soft iron about $\frac{3}{32}$" thickness, and is rivetted to a thin steel carrying-spring. The actual contact is separate from the armature proper, being carried on a small steel reed. This reed is fixed to the wall of the set by the same screw fixture as the armature spring, but is rapidly, under the influence of the blow, and thereby make a rapid, clean break.

Also, it will be observed that in this arrangement the reed is left proportionately longer in contact with the central screw point, so that the primary current has more time to grow and so saturate the iron core of the induction coil with magnetic lines of force. As

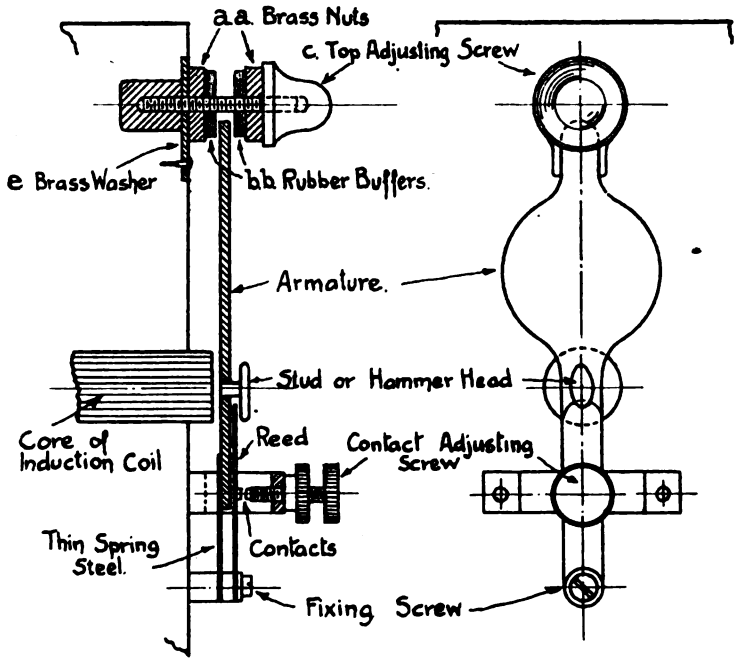

Fig. 9.

separated from it by a small brass distance-plate. The top of the reed passes beneath the overhanging edge of a stud or hammer-head carried by the armature, and as the latter moves forward under the attraction of the core, it travels some distance, gathering speed as it does so, before the edge of the hammer-head engages the top of the reed, and thereby breaks its contact with the other point. When this does take place, however, it is easily seen that the impact of the moving hammer-head will cause the reed to spring forward previously mentioned, both these features are conducive to greater radiation efficiency.

The distance of the reed from the edge of the hammer-head stud is controlled by the centre screw, whilst the swing of the armature between the rubber buffers or springs is adjusted by means of the upper screw.

With this break the spark frequency can be varied between 120 and 300 per second without any serious loss in efficiency.

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GENERAL CARE OF BREAK CONTACTS.

Contact points should always have a perfect surface, and should meet truly and over their whole area. The points may be ground on an oil-stone using the locking-nut (reversed) as a jig. They are expensive items nowadays to replace, and it is well worth while to treat them carefully.

Each time a transmitter has been used in the air, the contact points should be overhauled. It is better to be sure on the ground than sorry in the air.

SPARK GAP.

The spark gap should be adjusted before the set is placed in the bus, and the locking-nuts screwed tightly up in order to prevent subsequent displacement from vibration when in the air. A good dense spark springing equally from all parts of the discs indicates the correct distance—approximately 1.5—2 millimetres. Too close a gap gives rise to a "flame" discharge, which should be avoided. The discs should be frequently examined and kept scrupulously clean.

SHUNT CONDENSER OF INDUCTION COIL.

This is, perhaps, a relatively insignificant little adjunct, but it plays an important part in securing the general efficiency of the set, so that a few words about it may not be out of place.

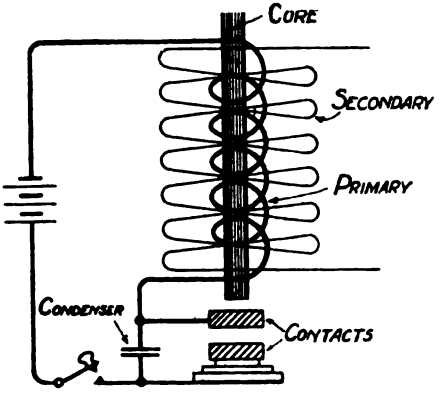

Fig. 10.

The condenser is placed in shunt across the make-and-break as shown in Fig. 10 and its function is to prevent sparking across the points when they break contact.

At the instant before break the primary circuit is surrounded by a heavy magnetic field, built up by the flowing current and its inductive action upon the iron core. At the moment when the points separate, this field instantaneously collapses, and in so doing cuts the coils of the primary winding and induces in it a high transient value of e.m.f.

In other words, the circuit "kicks" against the disturbance to its state of equilibrium, the direction of this reactive impulse being such as to tend to maintain the flow of current previously existing.

As at the moment of break, the points are still barely separated, this induced e.m.f. would be sufficient to spark across the thin layer of intervening air, and thus maintain a conductive path the effect of which would be to prolong the break, were it not for the shunt condenser which offers a more convenient path and reservoir for the momentary rush of current so created.

Its effect, therefore, is to ensure a clean, sharp break in the primary, and consequently the highest possible value of induced e.m.f. across the ends of the secondary for application to the spark-gap.

When the points again make contact, they short-circuit the condenser plates, which are thereby discharged ready for the ensuing break.

(To be continued.)

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Aviation Notes.

THE TRANSATLANTIC FLIGHT.

FOR four long years of bloody war, heroism has been a commonplace, and men have risked their lives and died in millions, having no witnesses other than their comrades, and, for the most part, with no audience outside a small circle of kith and kin, to hear and applaud the story of their efforts.

Six months have barely elapsed since that time, and already it is possible for two gallant men by risking their lives in a single daring enterprise to rouse the feelings of the whole country to an extent almost without parallel.

It is not so much values that have altered as the focus of the public eye. Gallantry will always receive its full measure of appreciation when it can be distinguished. In the welter of war it is so often lost in the crowd.

Photo: F. N. Birkett.

Mr. Harry Hawker.

The details of the flight have been told so often that they need no repetition, the sudden start by the Americans for the Azores *en route* for Europe, the sporting instinct which led Hawker and Grieve to make their attempt in the face of weather conditions that were certainly no more favourable than those that had till then kept them earth-bound for two months. Followed seven days of silence when it was known that they had failed, and fear grew to a practical certainty that both had paid the last penalty for their daring. Finally came the dramatic climax of their reappearance from the unbeaten track of the Atlantic on the now famous ship "that carried no wireless"; and their triumphal return from Thurso to London when all Scotland and England besieged the railway stations to do them honour.

So far as navigation was concerned, wireless played no part. The Sopwith

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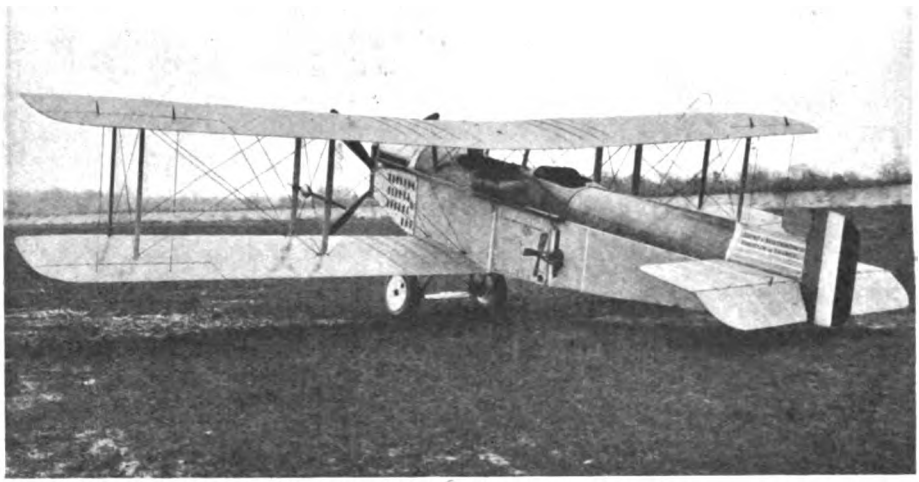

Photo: Giles' Agency.

The Sopwith machine on which Mr. Hawker and Commander Grieve attempted the non-stop Atlantic flight.

was originally fitted with a 2-kilowatt spark set (R.A.F. No. 55A), but this appears to have been damaged and discarded during the trials.

A lighter service set was subsequently sent over, but unfortunately it arrived only just before the flight was made, and was apparently fitted in hurriedly and without proper opportunity of testing. This was the 52A—a modification of the No 1. Transmitter (generally known as the Sterling) which has been described in the last two issues of the WIRELESS WORLD. It is somewhat heavier than the No.1, and has a range of between 30 and 40 miles with crystal reception. A self-excited alternator, driven by a wind screw fixed in the slip stream of the propeller, supplies the primary current, thus dispensing with the battery and make-and-break.

The 52A has been used to a considerable extent in the service, and is known to be a very reliable and efficient set within the limits for which it was designed.

Obviously though, even when working at its best, its only utility so far as navigation was concerned on the trans-atlantic flight would be confined to picking up location from passing ships. No direction-finding apparatus of the radio-goniometer type was carried by the Sopwith.

From Commander Grieve's own account, he found it very troublesome to keep a true course even approximately, and he expresses the opinion that the future of air navigation undoubtedly lies with directional wireless "when this has been perfected."

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THE AMERICANS.

Meanwhile, when all has been said about our own men, the Atlantic has been crossed by the Americans. True, it was done in stages, and the American Navy was strung out along the course. But that does not detract in any way from the merit of the performance. They had chosen the southern route deliberately, partly because the weather conditions were expected to be better, and partly because of the break allowed by the Azores.

The record of the journey shows that the undertaking was no light one, and but adds to the credit due to Lieut.-Commander Read.

The three seaplanes, NC1, NC3 and NC4, left New York on May 8th for Trepassey Bay, Newfoundland. The NC4 was forced to descend off the coast of Mine owing to engine trouble, but the two others reached Halifax safely after a flight of nine hours. On May 10th, these two completed the journey to Trepassey Bay, and on May 15 they set out for the Azores.

Two futile attempts were made on that day, the first with a crew of six, and the second with a crew of five. In neither case would the machines rise from the water, so they were put back until the next day.

Meanwhile the NC4 had been repaired and had reached Trepassey Bay, and on the evening of May 16th, all three planes started on their long-distance trip to the Azores, a distance of 1,400 miles, each carrying a crew of four.

Only one, the NC4, made the passage, reaching Horta, in the Island of Fayal, after a flight of 15 hours 18 minutes.

The NC1 was forced to the sea some 200 miles north-west of Fayal. After being afloat for five hours its crew was rescued by the steamer Ionia. The plane itself subsequently sank.

The NC3 had an even more adventurous passage. She was forced down to the sea some 200 miles from Ponta Delgada—the official destination—and after being lost for some days succeeded in arriving safely at that port, having "taxied" the whole distance through a heavy gale.

Meanwhile the NC4 had reached Ponta Delgada, and on May 27th safely traversed the 800 miles of sea between that point and Lisbon, in just under 9 hours.

Photo: Topical Press Agency

Commander Read of the N.C.4.

The final stage of the journey was from Lisbon to Plymouth, some 800 miles across the Bay of Biscay. A start was made on May 30, but owing to engine trouble the machine was forced to descend at Mondego after covering about 100 miles. The following day, however, saw the end of the journey, the NC4 arriving at Plymouth at 2.20 on the afternoon of the 31st.

Details are not available concerning the exact wireless equipment of the American planes, but Commander Read stated they had received messages from land stations over a range of 1,600

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miles, and that their own signals had been picked up 700 miles away. The latter range is particularly good for an air-borne set.

The flight marks a definite step in the progress of aviation. It is a record of success won by indefatigable effort in the face of unfavourable circumstances, and in spite of mishaps that would be sufficient to daunt any but men of indomitable spirit. The safeguards afforded by the chain of American Naval ships, of which we have heard so much, did not prevent the loss of the NC3; nor was it of much assistance to the NC1.

The credit is to the Americans, and it would become us ill to attempt in any way to "damn it with faint praise."

THE TARRANT TRIPLANE.

Disaster befell the Farnborough mystery bus on her maiden flight. The laborious work of over nine months was smashed to firewood in as many minutes. Both the pilot, Captain F. G. Dunn, late R.A.F., and his assistant, Captain P. Townley Rawlings, D.S.C., sustained fatal injuries, whilst the four passengers were all more or less seriously hurt.

What apparently occurred was that when the machine had acquired a speed of about 35 miles an hour, the pilot began to feel doubtful whether he could "take off" on the tractors only, and opened out the "pushers," with the result that she heeled over, dug her nose into the ground, and half somersaulted.

ADVENTUROUS R34.

Towards the end of May the R34 set out from Inchinnan on the Clyde to East Fortune, a distance that should have taken two hours. She struck a fog on her way, lost her bearings, and commenced a wandering cruise that lasted for 21 hours, before finally coming home to roost.

She carried a crew of 31, three dogs, and a cat, and as there was no other food on board, the quadrupeds displayed unusual animal sagacity in securing accommodation in inacessible positions, whilst the passengers contemplated moodily the prospect of combining the modern art of Aviation with the ancient cult of Anthropophagy.

Luckily before the fatal lots were drawn, wireless messages from Flamborough and Berwick brought the wanderers back to their bearings and averted the unpleasant fate that threatened the plumper members of the crew.

Photo: *The wreck of the Tarrant triplane.* Topical Press Agency.

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The Construction of Amateur Wireless Apparatus

This series of Articles, the first of which was published in our April number, is designed to give practical instruction in the manufacture of amateur installations and apparatus. In the following article the author deals with the important question of Inductances. The Wireless Press, Ltd., has arranged with Marconi's Wireless Telegraph Co., Ltd., to supply complete apparatus to the designs here given, as soon as Amateur restrictions are released.

Article Four.—INDUCTANCES.

THE standard unit of inductance chosen for use in ordinary electrical engineering is the *henry*. Now the frequency of the alternating currents flowing in the oscillatory circuits of a wireless transmitter or receiver is so high that the henry is much too large to be convenient for the specification of inductance for wireless purposes. The inductance of the windings of an oscillatory circuit is therefore generally measured and stated in *microhenries;* that is, in millionths of a henry. The values of inductance employed vary from a few microhenries (mhys) in the case of a short wave primary circuit for a spark transmitter, to 50,000 mhys or more as for the secondary winding of a long wave receiving jigger. It is very necessary that the amateur should familiarise himself with the appearance of coils of varying inductance, so that he can form a rough estimate of the inductance of a coil simply by looking at it. This is not so difficult as one might imagine at first sight, and once the faculty is acquired it is of immense value when making up receiving circuits. It may be of some assistance in this respect for the amateur to remember that a coil wound with one layer of No. 20 S.W.G. double silk covered copper wire on a former about 3 inches in diameter by 4 inches long has an inductance of about 400 microhenries. Also, assuming that we keep the dimensions of the coil constant but wind it with wires of different gauges, the inductance will be proportional to the square of the number of turns on the coil. We do not propose here to give any detailed instructions for the calculation of inductances; data of this nature can be found in many text books and pocket books.

INDUCTANCES FOR TRANSMITTERS.—In the article on aerials and earth systems we laid great stress on the importance of avoiding all constructions which would lead to the introduction of unnecessary resistance into the aerial circuit. This applies more especially to transmitting aerials. For the same reason it is desirable to design the aerial tuning inductance and jigger primary of a transmitting set so that the high frequency resistance is kept as low as possible. This is why bare copper tube is often employed in this connection. The tube can be formed into a spiral and supported in any convenient

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manner. Copper petrol piping, as used on motor cars and motor cycles is very suitable for the purpose. The pipe need only have very thin walls as owing to the "skin effect" the current is confined to the surface of the conductor. Stranded wire is also much used for winding the inductances of a transmitting circuit. The amateur should note that it is absolutely necessary that each individual strand be separately insulated. It is of no advantage to use 7/16 standard conductor for the construction of a jigger primary; since the conductors forming the cable are not separately insulated, it behaves just as though it were a solid conductor of equivalent surface. Also it should be noted that there is no particular advantage in increasing the sectional area of a solid conductor beyond a certain size (depending upon the frequency), because eddy current losses in the copper rise as the size increases, and consequently the reduction in ohmic resistance resulting from the greater cross section is negatived by the larger losses when the conductor is traversed by high-frequency current. The mode of laying up the stranded wire is also of great importance. Ordinary cables used in electrical work, such as 7/16 flexible wire, consist of a single wire running down the centre of the cable with six wires laid round it in a spiral of very coarse pitch. It is easy to see that if we take seven separately insulated wires and lay them up in this manner the outside conductors will be considerably longer than the wire forming the core of the cable. It is obviously undesirable to have the separate conductors of different lengths. Also, in this method of laying up, each wire preserves its relative position with reference to the centre of the cable throughout its whole length. In order to minimise "skin effect" it is desirable that a surface conductor at one point in the cable should be a centre conductor at another point and so on. In this manner we obtain the most uniform distribution of current over the whole cross section that is possible. These conditions are most simply met by the process of laying up in threes. In this method three insulated conductors are taken and laid up spirally together to form a cable. No core is used. Then three of these cables are taken and laid up spirally, forming a cable of nine conductors. Then three of the nine conductor cables are laid up—and so on until a cable of the required size is obtained. If the amateur will study this method of construction he will see that—

(1) Each conductor is the same length, and

(2) Every conductor appears on the surface at different points in the cable, and also passes to the centre.

A model can easily be made by laying up a number of lengths of smooth string in this manner; and if different coloured strings are used, the path of any individual thread can be easily traced out. Stranded conductors of this type are generally specified by stating the number of "threes" in the cable. For instance a cable consisting of twenty-seven strands of No. 30 S.W.G. copper wire is described as $3 \times 3 \times 3/30$, and if each strand is double silk covered, the letters D.S.C. are placed after the figures denoting the size.

In order to reduce the overall diameter of the finished cable, enamelled wire is largely used for the component strands. This covering is quite satisfactory as far as insulation goes, but it has the disadvantage that some types of enamel are very difficult to remove for the purpose of making connection on to the conductor. It is most necessary that good contact should be made on to each

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strand of the cable. The best method is to bare each conductor individually, care being taken to avoid breaking any strands, then the whole bunch is sweated together to form a solid end to the cable. Soldering compounds should not be used in this operation, as, if the strands are very fine, corrosion is certain to result with a corresponding rise in the resistance of the contact or joint. It is useful to note that some enamels are soluble in acetone. When this is the case cables made up from wire so insulated can be most easily cleaned for soldering by washing off the enamel with acetone. The amateur should take great care that no strands are broken in the cleaning operation. The presence of an unconnected strand in the cable is certain to cause a rise in the high-frequency resistance, and the conductor would be better without the strand altogether.

It will perhaps be of help to the amateur if we give a brief description of the way he should set out to construct the primary circuit of a coupled circuit spark transmitter. We shall assume that he has in his possession a spark coil of some type and that his licence allows him to employ a wavelength of 150 metres for transmission. Now the design of the circuit will be entirely dependent upon the value of the maximum capacity which the coil will charge, and this depends upon the power of the coil and the gauge of wire with which the secondary is wound. The best way to determine this capacity is by experiment. Take a number of sheets of glass—old half-plate negatives from which the emulsion has been removed are very suitable—and have at hand a number of sheets of tinfoil cut to the correct size to form the plates of the condenser. Now commence building up a condenser with the glass and tinfoil, and after each plate is added test the character of the spark by connecting the secondary terminals of the coil and the gap (whatever type it may be) across the condenser. Now continue increasing the number of plates in the condenser until the spark becomes ragged and irregular. We then know that the capacity is just too large for the coil to charge satisfactorily, and the correct value will be given by taking off one or two plates. This condenser may be employed in the finished transmitter, or its capacity may be determined by comparison with a standard condenser or inductance and the actual condenser of the correct size purchased. Having obtained our condenser the required inductance to give the desired wavelength may be determined by a similar process of experiment. We will suppose for example that the amateur has decided to make a self-supporting spiral of copper tube for the inductance of his jigger primary circuit. Take a wooden former of the correct diameter and say 1 foot long. Now, a spacing of half an inch between the turns will be very suitable; therefore wind three or four turns of insulated wire on the former spaced $\frac{1}{2}$ inch apart. Connect these turns in series with the gap and condenser and set the coil in operation. The wavelength to which the circuit is oscillating can be determined by making an observation with a wavemeter in the vicinity. Note this wavelength; if too long remove some of the wire from the former, if too short wind on some more turns. By this process of trial and error the exact number of turns required can be found out. Now by unwinding the wire from the former the amateur can at once measure its length, and thus obtain a figure for the quantity of copper pipe to be purchased. Of course, it is essential that the pipe should be made up into a helix of exactly the same

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dimensions as the experimental winding on the former.

The amount of aerial tuning inductance required will be dependent upon the dimensions of the aerial which is available for transmitting, and provided that the amount necessary is not very great it will be quite good enough to employ solid conductor of at least the same section as the aerial wire itself. Thus, if the aerial is made up from 7/19 silicon bronze wire, and has only one wire in it, 7/19 copper rubber insulated cable will be quite suitable. The amount of wire required can be determined experimentally by winding a former of the same dimensions as the finished coil with copper wire, correct spacing between turns being preserved. By inserting this coil in series with the aerial to earth, and exciting the circuit by means of a shunted buzzer, the wavelength of the system can be measured. Turns can then be added or taken off the coil until the desired wavelength is obtained. Then using the experimental coil as a model the finished inductance can be made up. It is of advantage to be able to adjust the tuning of the aerial between small limits in order to secure exact resonance with the primary circuit. The amateur can get this adjustment by making the permanent aerial tuning inductance with, say, two turns less than the required number; then by employing a small extra inductance, consisting of six turns of bare conductor formed into a spiral of the same diameter as the fixed inductance, provided with an adjustable contact clip, the necessary fine tuning adjustment can be obtained. If it is found that a large amount of inductance is required to bring the aerial up to the licensed wavelength, we recommend the amateur to make up his tuning coil from stranded cable. It will be necessary to make a former of insulating material, such as ebonite, on which to wind the cable, as it is not stiff enough to be self-supporting.

INDUCTANCES FOR RECEIVERS.—It is not necessary, in the case of a receiving circuit, to take such extreme care to reduce all resistances to the lowest possible limit. It is a mathematical fact that, even though the receiving circuits were absolutely ideal and possessed no internal losses, the efficiency of a receiver can never exceed 50 per cent. In any case when a three-electrode valve is employed for magnification of the received high-frequency current, the damping of the circuit can always be reduced to zero by a suitable adjustment of the reaction coupling. Consequently, for all ordinary receiving circuits, we can rule out as unnecessary the use of stranded wire. This wire is expensive when purchased in the quantities required for the coils of a receiving circuit, and the advantage gained is too small to be of account. There are cases, in commercial work, where stranded cable must be employed. For example, an intermediate circuit consisting of a large air condenser shunted by two small inductances would necessitate the use of stranded cable for the coils; but the average amateur will not require circuits of this special nature.

The coils for the oscillatory circuits should always be wound in only one layer. This is desirable in all cases and absolutely essential where the ratio of inductance to capacity is large. This latter condition obtains in the case of a jigger secondary circuit, where the potential produced across the tuning condenser is applied directly to the rectifier (e.g., crystal or valve) or to the grid of a three-electrode valve. This circuit must be designed so that the applied potential difference is the maximum possible, and this condition implies that the condenser should be as small as possible

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and the inductance correspondingly large. If the inductance coil were wound in two layers, the terminal ends of the coil would be directly over each other, separated only by the thickness of the insulating covering of the wire. The ends therefore would have a considerable capacity to each other, and this capacity would be in parallel with the tuning condenser connected across the coil. Consequently the total effective capacity in the circuit would be much greater than if the coil were only a single layer one. It is obvious that the ideal case is exemplified in a single layer coil whose natural wavelength is that of the received signal; this is not a suitable arrangement in practice as adjustment of wavelength is necessary, and this could only be obtained by a variation in the length of the coil.

Various methods have been proposed and used for increasing the inductance of a coil, without increasing its capacity unduly, and at the same time keeping the dimensions small. Lap and pile windings are examples. These windings are not easy to do with fine wire by hand, and since the amateur is not usually concerned with keeping the weight and size of his apparatus down to the smallest possible limit, we advise him to stick to simple single layer windings.

With regard to the gauges of wire to be used for different circuits, No. 20 or 22 is very suitable for aerial tuning inductances, intermediate circuits, etc.; No. 28 or 30 is good for jigger secondaries. All wire should be high conductivity copper and double silk covered. The finished coils should be given two thin coats of shellac varnish, and, if the former will stand heat, should be baked in a warm oven or before a fire. The coils in any case must not be used until the varnish is quite hard and dry. Shellac varnish, before quite hard, is quite a good conductor.

Patent Section

123,081. Electric signalling and telephony. Ehret, C. D., 2118, Land Title Building, Philadelphia, Pennsylvania, U.S.A. February 1st, 1919. No. 2585. Convention date, February 1st, 1918. Not yet accepted. Abridged as open to inspection under Section 91 of the Act (Classes 40 (iv) and40(v)).

Telephoning or signalling between stations upwards of 100 miles apart is effected over line conductors having a resistance greater than 25 ohms per mile, amplifiers C^1 being arranged at points a plurality of wavelengths apart. The speech or signal waves are preferably impressed upon high frequency current from a generator g^1. The resistance of the conductor is at least 25 ohms per mile for pole line and 50 ohms per mile for cables, and currents of frequencies from 20,000 to 200,000 cycles per second are used. The amplifiers preferably of the audion or thermionic type, may be from 50 to 200 miles apart. The lines may be loaded with inductances *l*, inductive or non-inductive leaks *k* being arranged as shown in Fig. 4. A source of high-frequency current g^1 may be connected to line at a point mid-way between the terminal station.

FIG. 3.

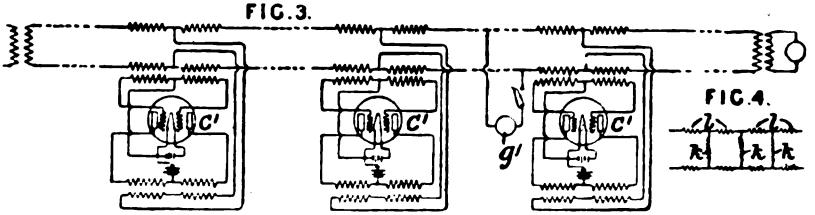

FIG. 4.

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The Library Table

ALTERNATING CURRENT ELECTRICAL ENGINEERING.

By PHILIP KEMP, M.Sc. TECH. (VICT.), A.M.I.E.E.

London: Macmillan & Co., Ltd., 17s. net (pp. 494.)

THIS text book is intended as a general volume covering the bulk of the work usually associated with the title of Alternating Current Engineering. It is designed to cover the syllabus for the Alternating Current paper of the City and Guilds Examinations, and for the B.Sc. Examination in Electrical Engineering. The matter dealt with in this book is essentially of the type and style usually associated with College lectures, which are intended to be supplemented by separate Laboratory or Practical Courses. The commercial side of A.C. Engineering is, therefore, not touched upon at all, nor is what may be termed the "manufacturing" side which is concerned with constructional details and the various forms of A.C. machinery as actually put on the market. For the purposes, however, of College courses of the above type the book appears to cover the ground in a very excellent manner, except in a few minor details. This particular subject is from its nature one that is quite inseparable from mathematical reasoning and formulæ, but the author has endeavoured to simplify these down to their essential parts only, and to put the more advanced (calculus) explanations in the form of footnotes which may be passed over by the uninitiated reader. This practice, however, has not been consistently followed, as in one or two places the integrations have been incorporated into the text.

The book commences with the usual type of introduction dealing with the production of an E.M.F. from a varying magnetic field. A useful feature in this section is the emphasis given to the idea of "linkages" and "change of linkages," rather than to the "cutting" of flux by a conductor, and also to the importance of considering non-sinusoidal wave forms as well as those following a pure sine curve. The general tendency, however, of modern practice is in the direction of more uniform sine wave forms so that these considerations are gradually becoming less important.

Two very useful chapters are devoted to vectors and circle diagrams, the latter being treated very fully. A useful distinction has been made in the form of the arrow head put on the vectors to distinguish between the various vectors in a diagram representing voltage, current, magneto-motive force and flux. The distinctions are, however, rather confused in the printing of some of the diagrams throughout the book. Chapter VI. treats of Capacity and Condensers and summarises the effects of capacity in alternating current circuits and networks, as well as their various uses and the meaning and effects of Resonance. A very limited table of Specific Inductive Capacities is, however, given and some of the values quoted do not entirely agree with common experience.

The author seems to pin his faith entirely to paper condensers for practically all purposes, although the Moscicki glass tube condensers are briefly described. Mica condensers seem to be quite "outside the pale" in spite of

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their increasingly extensive employment for many purposes. The sections on the uses of condensers are also somewhat brief, while such a very extended application as their use in Magnetos is altogether omitted.

The wave forms of alternating current are further dealt with in two Chapters, IX. and X. The pages devoted to Harmonic Analysis are somewhat limited, and only two methods are discussed, probably because the author prefers his own method (for which good tables and data are given) to any other. A considerable number of ways of analysing a periodic curve have been published latterly, and some mention might perhaps have been made of some of these, although, on the other hand, the average college student has quite enough to remember if he knows merely one workable method without risking possible confusion by studying several different analyses. The sections devoted to the effect of magnetic saturation and hysteresis on the wave-form of the current, as well as the harmonics that are introduced under other conditions—such as by an A.C. Arc—are instructive from the wireless point of view, especially in connection with the application to static and other forms of Frequency Raisers.

Chapters XI. and XII. on A.C. Instruments begin the more specialised portion of the book as distinct from the purely general introductory matter. A feature rarely found in text books is a description of the cathode-ray oscillograph and its method of use, although important recent improvements such as the use of incandescent cathodes, etc., are not mentioned. These improvements make the instrument much more useful in operation, and enable photographic records to be more readily obtained. The influence machine method of excitation can also with advantage be replaced by high voltage batteries or by rectified alternating current obtained by the use of rectifying valves.

The all-important Transformer, Alternator, and Induction Motor are given three chapters each—one of which is in each instance devoted to design. These design chapters appear particularly good for the student's use as giving a plain, straightforward treatment without unnecessary complications, provided that the details of most recent practice (in the way of efficiencies, regulation, etc.), are supplied to the student by his lecturer.

The transmission of power by overhead lines and underground cables is treated mathematically in Chapter XX., while Synchronous Motors and Rotary Converters each receive a Chapter.

A very useful Chapter is devoted to Power Factor Improvement, and treats mainly of the over-excited synchronous motor and the various conditions under which it may be employed. The use of condensers for this purpose is also briefly discussed.

Mercury Vapour Converters and Electrolytic Rectifying Valves are discussed briefly, while the book closes with two Chapters devoted to the series and repulsion motors.

Taken as a whole the book gives a very good treatment of all parts of the subject and misprints are remarkably few, although considerable confusion may arise through the use of the section heading "Ohms Law for Alternating Current Circuit" on p. 10, when the complete (impedance) formula is not given but merely the usual form of Ohms Law, as used for D.C. circuits. A slight error appears on p. 135 where two discs referred to in the text are shown in the accompanying figure as squares; and again on p. 221, the expression "length of the core . . . . . =16.4 cm." should be "side of core section. . . . . =16.4 cm."

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Personal Notes

NEW HONOUR FOR SIR O. LODGE.

ON June 6th at Clarence House, the Duke of Connaught presented to Sir Oliver Lodge the Albert Medal of the Royal Society of Arts, which was awarded to the famous scientist "in recognition of his work as the pioneer of wireless telegraphy."

MR. CHARLES BRIGHT KNIGHTED.

His Majesty the King has conferred on Mr. Charles Bright, F.R.S.E., M.Inst.C.E., M.I.E.E., the honour of Knight Bachelor. Mr. Bright is consulting engineer to the Commonwealth of Australia, and has been engaged in the construction and laying of cables in many parts of the world. He has served on numerous Committees, including the R.F.C., Inquiry Committee of 1916, and represented the Australian Commonwealth at the International Radiotelegraphic Conference in 1912.

MARCONI COMPANY'S NEW DIRECTOR.

Marconi's Wireless Telegraph Company, Limited, announces that Sir Charles J. Stewart, K.B.E., has been elected to a seat on the Board. Sir Charles, who was born in 1851, is a barrister-at-law, having been called to the bar in 1883. He was Senior Official Receiver to Companies Winding Up from 1890-1897, when he became Clerk to the London County Council. Sir Charles was Chairman of Messrs. S. Allsopp & Sons from 1900-1907, and in the latter year he became Public Trustee, which position he held until a recent date.

MILITARY CROSS FOR EX-WIRELESS OPERATOR.

Our congratulations go to Capt. R. W. Newcomb, who was decorated by the King with the Military Cross on May 17th last at Buckingham Palace, "for conspicuous bravery in the field."

Immediately prior to the war, Mr. Newcomb (who was in the employ of the Société Anonyme Internationale Télégraphie sans Fil) was operator in charge on board the S.S. "Lapland," but on the outbreak of hostilities he immediately joined up in a London Regiment as a private.

NEW APPOINTMENTS.

Mr. F. C. Raphael, M.I.E.E., has been appointed manager of the Cable and Wireless Department of the Edison Swan Electric Company, Limited (Ponders End, Middlesex). Prior to the war Mr. Raphael was well known as the editor of "The Electrician" and "Electrical Engineering" successively. Shortly after the outbreak of war, being too old for the Army, he joined the Royal Naval Anti-Aircraft Corps, but subsequently obtained a commission in the London Electrical Engineers, R.E. (T). At the time of his demobilisation he held the appointment of Assistant Inspector under the C.I.R.E.S.

Mr. A. H. Morse, A.M.I.E.E., Mem. I.R.E. (New York), has been appointed Managing Director of the Marconi Wireless Telegraph Company of Canada, Ltd. Mr. Morse is well-known in North American wireless circles.

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Company Notes

THE MARCONI INTERNATIONAL MARINE COMMUNICATION COMPANY, LIMITED

DIRECTORS' REPORT.

The Directors submit herewith the Balance Sheet and Profit and Loss Account for the year ended 31st December, 1918.

The Company's business has continued to show substantial expansion. The Gross Revenue for the year amounted to £563,205 7s. 3d., showing an increase over the preceding year of £92,547 10s. 8d. This increase was again derived mainly from rentals of additional ships fitted. It will be borne in mind that the restrictions on private messages from ships at sea have only been removed since May 1st of this year. The net Profit for the year amounts to £186,341 17s. 1d.

In the Directors' Report last year, Shareholders were advised that His Majesty's Government had decided to make the provision of Wireless Telegraph Apparatus compulsory on merchant ships of 1,600 tons gross and over, and to require that two operators be carried on all these vessels. At the request of the Board of Trade, this Company undertook to provide the necessary apparatus and the trained operators. It, therefore, became necessary to arrange facilities in all parts of the country for the simultaneous training at the Company's expense of a very large number of operators. Thereby a large and extraordinary expenditure has been incurred during the year under review which will not recur, and it is responsible for a small reduction in the Profits compared with the preceding year notwithstanding the substantial increase in the year's revenue.

The losses sustained in consequence of attacks upon the mercantile marine during the year 1918 have been debited to Profit and Loss.

The Directors have pleasure in recommending the payment of a final dividend of 10 per cent. for the year 1918, which with the interim dividend of 5 per cent. paid in January last will make 15 per cent. for the year.

During the year 47 Debentures of a par value of £940 were redeemed.

The total number of Public Telegraph Stations owned and worked by the Company on the high seas increased from 2,265 at the end of December, 1917, to 2,549 at the end of December, 1918. The organisation of the Company, together with that of its associated Companies, with a total of over 4,000 mercantile vessels fitted with Marconi Telegraph Stations, has continued to render inestimable service.

The Amalgamated Wireless (Australasia) Limited, in which this Company is interested, has paid a Dividend of 5 per cent. in respect of the year ending 30th June, 1918.

The increase of the Capital of the Company to £1,500,000 was duly confirmed at the Extraordinary General Meeting, held on the 2nd May, 1919, and 600,000 new Shares were offered to the Shareholders, at par, on the 10th May last.

An official quotation on the London Stock Exchange was granted for the Company's Shares in April last.

It is with regret that the Directors have to record the names of further members of the Company's Telegraph Staff who have lost their lives in the service of their country.

The Directors regret to record the death, on the 9th May, of Mr. Henry Spearman Saunders who had been a Director of the Company since its incorporation.

Since the last Ordinary General Meeting, Mr. Sidney St. J. Steadman and Sir Charles J. Stewart, K.B.E., have been appointed Directors of the Company. In accordance with Article 67, these gentlemen retire and, being eligible, offer themselves for re-election.

The Directors retiring by rotation are Mr. Henry William Allen, Mr. William Walter Bradfield, and Mr. Maurice Alfred Bramston, who, being eligible, offer themselves for re-election.

The Auditors, Messrs. Cooper Brothers and Co., also retire and offer themselves for re-appointment.

By Order of the Board,
H. W. CORBY,
Secretary.

Marconi House,
Strand, London, W.C.2.
6th June, 1919.

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THE MARCONI INTERNATIONAL MARINE COMMUNICATION COMPANY, LIMITED.

BALANCE SHEET, 31st December, 1918.

Dr. *Cr.*

	£ s. d.	£ s. d.		£ s. d.
To CAPITAL—			By PLANT, APPARATUS, FURNITURE AND STORES	602,301 1 0
Authorised and Issued.			*Note.*—Owing to the war it has not been possible to obtain certified Inventories for Apparatus and Stores amounting to £104,411 7s. 11d. The balance, £407,889 13s. 1d. has been certified by representatives of the Company.	
600,000 Shares of £1 each		600,000 0 0	By LICENCE AND RIGHTS AND SHARES IN ASSOCIATED COMPANIES ...	220,086 11 7
To 5,567 5½ PER CENT. FIRST MORTGAGE DEBENTURES OF £20 EACH		111,340 0 0	By DEBTOR BALANCES	335,723 17 9
To GENERAL RESERVE ACCOUNT		258,013 13 0	By CASH AT BANKERS AND IN HAND	52,575 3 11
To RESERVE FOR OBSOLESCENCE OF PLANT		50,000 0 0	By INVESTMENTS IN WAR LOANS	301,308 13 7
To CREDITOR BALANCES		200,881 18 9		
To PROFIT AND LOSS ACCOUNT—				
Balance as per Appropriation Account, 31st December, 1917	105,417 19 0			
Balance of Account for the year ending 31st December, 1918	186,341 17 1	291,759 16 1		
		£1,511,095 7 10		£1,511,095 7 10

H. RIALL SANKEY, HENRY W. ALLEN } *Directors.*

PROFIT AND LOSS ACCOUNT for the year ending 31st December, 1918.

Dr. *Cr.*

	£ s. d.		£ s. d.
To SALARIES AND DIRECTORS' REMUNERATION	40,168 11 1	By SHIPS' TELEGRAMS, CONTRACTS, RENTALS AND SUNDRY RECEIPTS	563,205 7 3
To GENERAL CHARGES	11,999 13 0	By TRANSFER AND OTHER FEES	239 6 6
To EXPENSES OF SHIP TELEGRAPH STATIONS, including loss of Plant and Apparatus and cost of training Operators	267,707 15 2		
To DEPRECIATION OF PLANT AND APPARATUS	51,242 18 0		
To DEBENTURE INTEREST	5,983 19 5		
To BALANCE CARRIED TO BALANCE SHEET	186,341 17 1		
	£563,444 13 9		£563,444 13 9

APPROPRIATION ACCOUNT.

	£ s. d.		£ s. d.
To INTERIM DIVIDEND of 5 per cent. for the year ending 31st December, 1918, paid 15th January, 1919	30,000 0 0	By PROFIT AND LOSS ACCOUNT, as per Balance Sheet	291,759 16 1
To PROPOSED FINAL DIVIDEND of 10 per cent. for the year ending 31st December, 1918	120,000 0 0		
To BALANCE carried to next Account, subject to Excess Profits Duty for 1916, 1917 and 1918	141,759 16 1		
	£291,759 16 1		£291,759 16 1

REPORT OF THE AUDITORS TO THE SHAREHOLDERS.

We have audited the above Balance Sheet with the books in London and accounts from Rome. We have obtained all the information and explanations we have required, and in our opinion such Balance Sheet is properly drawn up so as to exhibit a true and correct view of the state of the Company's affairs according to the best of our information and the explanations given to us and as shown by the Books of the Company.

COOPER BROTHERS & CO., *Chartered Accountants* } *Auditors.*

LONDON, *6th June*, 1919.

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Questions and Answers

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless telegraphy. Readers should comply with the following rules:* (1) *Questions should be numbered and written on one side of the paper only, and should not exceed four in number.* (2) *Queries should be clear and concise.* (3) *Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before.* **(4) The Editor cannot undertake to reply to queries by post** (5) *All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or if so desired, under a "nom-de-plume."* **(6) Will readers please note that as amateurs they may not at present buy, construct or use apparatus for wireless telegraphy or telephony. (7) Readers desirous of knowing the conditions of service, etc., for wireless operators, will save time by writing direct to the various firms employing operators.**

T. AERIAL (Cheshire).—Asks whether if two stations which lie E. and W. desire to communicate with maximum strength signals, their aerials should be parallel to each other, that is, N. and S.

(2) Would the same apply whether the downlead be taken from the ends or the centre?

Answer.—(1) In the first place an aerial is only directional to any useful degree when the length of the horizontal portion is several times the length of the downlead. In order that the aerial may radiate the maximum energy in a certain direction, the free ends of the aerial must point away from the station to which it is desired to transmit. The aerials in the above case would therefore point away from each other and would be in the same straight line.

(2) A "T" aerial is only very slightly directional. Curves showing the intensity of the field around an aerial will be found in most text books on Wireless Telegraphy.

If the receiving station is fitted with a wireless compass using a frame for the aerial, then strongest signals will be received when the plane of the frame points to the transmitting station, that is the plane of the frame will be in a line with the receiving and transmitting stations.

It is quite possible to obtain readable signals on a 5-ft. frame by using several audions in cascade.

MESSENGER (Christchurch).—(1) You ask "Is it true that there are more operators than can be employed?" This question is of such a comprehensive nature that we cannot answer it definitely. We are inclined to think that there is a steadily growing demand for wireless operators. (2) Not to our knowledge. (3) The Marconi International Marine Communication Co., Ltd., Marconi's Wireless Telegraph Co., Limited, Siemens Bros., and, of course, the Post Office. A very limited number of Shipping Companies employ their own operators.

H.S. (Biddulph Park, nr. Congleton).—(1) Six to nine months study at a good school, but it depends largely upon how long you need to attain the necessary operating speed. (2) and (3) Elementary arithmetic only.

C.D.H. (Seaford).—You would require a complete course of electrical engineering, plus a specialised study of high-frequency currents. Write to the various engineering colleges for prospectuses of such courses, stating what you want to do.

J.M. (Portsmouth).—(1) Yes, but not in that only, of course. (2) The fee for the P.M.G. examination in wireless is five shillings. Apply to the Secretary, G.P.O., London.

C.R.E. (Swine, nr. Hull).—(1) The wireless call of the S.S. *Titanic* which sank in 1912 was MGY. (2) Depends upon the rules of the club you propose to join. At present there is not a great activity amongst wireless clubs, owing to the restrictions on amateur working. Until a club is started near enough to your home for you to attend its meetings you might become a corresponding member of a club elsewhere. The Three Towns Wireless Club, 7, Brandreth Road, Compton, Plymouth, is willing to admit such members.

L.A.W., c/o G.P.O.—Asks: (1) Whether the formula in the Wireless Year Book for 1918 for the calculation of the capacity of concentric cylinders is correct?

Yes, this formula is quite correct when air is the dielectric used, as the Specific Inductive Capacity of air is 1. If any other dielectric is used then it is necessary to include in the numerator of the formula the value of the S.I.C. of the material used.

(2) We are unable to state the exact S.I.C. of paraffin waxed paper, but it would probably be about 2.

(3) It is not essential to have a battery connected in the grid circuit of a three electrode valve. In some valve receivers the grid potential is adjusted by means of a potentiometer connected across the battery used for the filament. The potentiometer can, however, be dispensed with, when the correct point on the characteristic curve of the valve is obtained by

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adjusting the plate voltage, and the temperature of the filament.

(4) What factors govern the sizes of wires and ratio of turns in a telephone transformer? *Answer.*—The current flowing in the primary side of the transformer, that is the detector side, the inductance of the primary side, and the current required to work the particular type of telephones used, are the principal factors which govern the sizes of wires used and the ratio of the number of turns. The design of the telephone transformers is somewhat empirical and is a matter of trial.

DALLY (Hastings).—Asks several questions about the cost of various pieces of apparatus used in connection with valve reception, and requires the names of the various grid valves. (1) It is almost impossible to give any indication of the cost of any apparatus for use in wireless transmission or reception, as no wireless apparatus has been on the public market since the outbreak of war, and we cannot forcast what prices will rule when the embargo is raised. Other circumstances which affect the cost of any wireless apparatus for an amateur are: (*a*) his ability and facilities for making it himself, (*b*) the range of the set, whether for receiving or transmitting, and, (*c*) the finish of the whole apparatus. A set can therefore be made with an outlay of a few shillings or as many pounds.

We are unable to furnish "Dally" with any names of grid valves as the valves at present are simply known as three electrode transmitting or receiving valves, a few having a type letter.

(2) What apparatus is required to convert an Auto-jigger crystal receiver into a valve receiver? *Answer.*—A three electrode receiving valve. A battery with a series resistance to light the filament of the valve; this battery would have to give a current of about .5 amps. so that an ordinary dry cell would not suffice; a high tension battery capable of giving from 100-200 volts. The exact H.T. Voltage required depends on the characteristics of the valve. A pair of H.R. telephones, or preferably a pair of L.R. telephones and a telephone transformer.

(3) In a heterodyne receiver what produces the waves at the receiver end? In a heterodyne receiver the waves or "beats" as they are technically known, are produced by superimposing on the circuit oscillations of greater or less frequency than the frequency of the waves received. Thus if the received waves have a frequency of 50,000 per second and oscillations of 49,000 per second are superimposed we obtain a musical note with a frequency of 1,000 per second in the receiver. There are several methods of obtaining these superimposed oscillations, the most usual being to couple a reaction coil connected in the plate circuit of the valve, to the coil connected in the grid circuit.

The coil in the grid circuit can either form the A.T.I. of the receiver or the jigger secondary coil.

(4) Continuous waves cannot be received on an auto-jigger receiver by including a single buzzer in the aerial circuit. It would be possible by using a double buzzer, that is two buzzers in series. Connecting a condenser across the buzzer terminals would have no effect.

(5) Yes, wireless telephone waves can be heard by anyone listening on a crystal receiver.

C.T.A. (Leicester).—(1) We regret we are unable to give the exact function of the condenser C.4 on page 95 of the May issue of the WIRELESS WORLD; perhaps the writer wished to insulate the filament and high tension batteries from earth, a somewhat unusual proceeding. As this condenser has a capacity of .01 mfd. its capacity would be very large compared to that of the aerial and would not, therefore, appreciably effect the wavelength.

(2) For remarks on the design of telephone transformers see our answer to L.A.W., c/o G.P.O., in this issue. We have obtained good results on a variety of circuits by using a small ignition coil similar to that used for motor car ignition before the high tension magneto came into use.

(3) Telephone transformers with a closed iron core are used, but from our experience they are little, if any, more efficient than an open core transformer.

D.A.N. (S.W.19).—Unfortunately D.A.N. gives no details of the coil with which he gets a ½-cm. spark at the electrode gap when it is disconnected, or whether only the secondary leads are disconnected and not the aerial circuit. The spark may be caused by the electrode rods acting as an Hertz resonator with the condenser across the break acting as the exciting agent.

SHARE MARKET REPORT.

There has been renewed activity in the share market for the various Marconi issues owing to the prospects of the Parent Company's claim against the Government, the improved position of the International Marine Company shown in the report which has just been issued and the proposed reconstruction of the Marconi Wireless Co. of Canada.

Prices are all well maintained as we go to press: Marconi Ordinary, £6. 3. 9; Marconi Preference, £5. 11. 3; American Marconi, £1. 10. 0; Canadian Marconi, 18s. od.; Spanish and General, 15s.; Marconi International, £3. 10. 0.

WANTED the following numbers of the "Wireless World":—April, June, 1913; June, July, 1917; January, February, March, April, May, September, 1918; February, 1919. Write with full particulars, price, etc., to Box N. Wireless Press Ltd., Marconi House, Strand, W.C. 2.

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THE
WIRELESS WORLD

No. 77
Vol. VII

AUGUST,
1919

"AVANTI ITALIA"

How British Wireless Men Helped Italy to Victory.

By Captain S. B. Balcombe.

NOVEMBER in France, 1917, with all the excitement of the break through by the Tanks at Cambrai caused enormous excitement for the B.E.F., but immediately it was known that reinforcements in the substantial form of several of the best divisions were to be sent to Italy to help our Allies to stay the Huns in their temporary victory of Caporetto, the excitement was even greater.

Each division that was "resting" or withdrawn from the line, was congratulating itself that it had been the lucky one selected, and when those five divisions which were actually chosen ultimately entrained for the sunny south, there were few pangs of regret at leaving those walls of mud which had been their abode for months past. The excitement of a new front, combined with the natural curiosity of the soldier as to how the Italian soldier compared in prowess of arms with the other allied nations, by whose side we had fought, and the wonderful scenery which one knew of as being unsurpassed, gave ample food for conversation. I, unfortunately, was debarred from taking part in the touring with the "Force," and had to go to England to get the wireless gear and the personnel to man it. The sorting out of "junk," the annexation of "gadgets" for experiments, and the wholesale confiscation of spares which were not on the official list of stores, together with the collection of the personnel all took up time, and December was well advanced before any definite news of a move became known.

The gear, which consisted of short-wave Bellini-Tosi-Marconi sets of latest pattern, aeroplane compass sets of the whirligig type, interception sets, and numerous other smaller sets was all packed up straight from the factories, and in due course we started off on the great adventure, fifty strong, with a multitude of packing cases, mast sections and charging sets, all stowed safely away on the same train.

During transit the stores at times very nearly came to grief. What they suffered from transference by crane from train to ship when embarking, and from ship to train on arrival at the other

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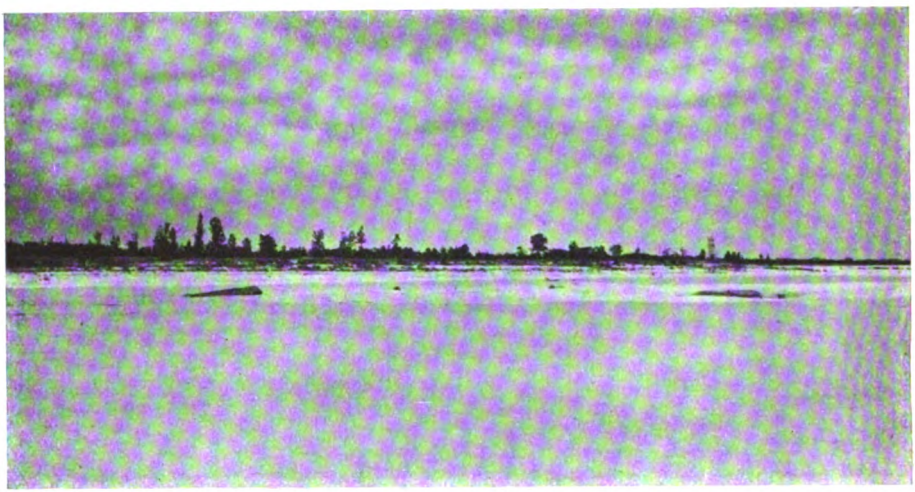

June 15th, 1918, on the Piave. Note the remains of the pontoon bridge.

side, with many bumps and bangs in the hold and at the quay side, nearly turned my hair white, and I prayed that some fairy godmother had kindly looked after the interior of the cases, as the prospects of doing any big repairs when we arrived were absolutely unknown, and the thought of having broken gear, and the necessity of sitting still whilst awaiting replacements from England was not a cheery prospect, as I knew by experience what expeditious results have been achieved when anyone at the front had asked for spares from England.

Anyhow the unpacking at our journey's end revealed nothing worse than a few missing terminals, or a valve or two broken, so that with our spares brought into operation and a few hours' work on the part of the instrument repairer, we were soon able to "get things going."

The powers decreed that the Piave front should be our destination and a few days' reconnaissance of the front gave me the opportunity to erect stations at points where the tactical situation demanded them.

With a wide expanse of the Venetian plain in front of us, no difficulty was found in obtaining good positions for the stations, and we made our headquarters at Treviso. Unfortunately this town was a marked place for the Hun bombing planes, and they gave us a right royal greeting on our first night's arrival, and kept it up to well towards the middle of March. To say the least of it, things were decidedly unpleasant and the group wireless headquarters had more than one escape, no less than 20 bombs falling within a radius of 100 yards, and on one occasion a bomb alighted within 20 yards of a wireless set without disturbing it. "Archies" also provided many thrills and an occasional "dud" which missed its mark landed in alarming proximity to a Bellini-Tosi set, greatly to the distraction of the operators performing at the time, but they carried on notwithstanding. Another bomb splinter made havoc of an hydrometer which the electrician was manipulating at the time the "egg" fell, and a call upon our reserve stock was afterwards necessary.

These planes afterwards had a very lively time with our own machines

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which carried out reprisals with great zest. The leader of these raids was the well known Canadian airman, Major Barker, V.C., D.S.O., M.C., and it will be interesting to readers to learn that this gallant officer, who acted upon wireless information supplied by aeroplane whirligig stations, was successful on more than one occasion in bringing them down or driving them off. He was very keen indeed on wireless reports of the enemy plane positions, and were he on the ground at the time the report was received at the aerodrome, he would immediately go up and endeavour to bring the enemy down.

The Hun wireless was singularly inactive during these months, and it was not until early in May that any sign of activity prevailed. This was interesting because from November, when the offensive ceased, until May, the Hun had been on the defensive and had not, with the exception of an occasional raid, undertaken any operations. Toward the end of May and the early part of June increased wireless activity was very apparent on the part of the Huns, and our wireless intelligence was kept very busy locating these stations. Later, in the middle of June, the increase in enemy stations was most marked and this led our "I" branch to make deductions, which were correct, that an offensive was imminent. How right these deductions were is borne out by the fact that the enemy offensive commenced on the morning of June 15th and ended in dismal failure. To what extent wireless was responsible for the correct deduction of the date of the offensive being made is perhaps for the staff to say, but one may conjecture that it paid no very small part.

During this battle a listening set was temporarily isolated together with the operators and interpreters, and I believe two of the men were killed. One of the survivors succeeded, however, in destroying the instruments and burying

The Italian lines on Monte Viali. There was a W/T station just by the gun in the (left) centre of the picture.

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On the Piave front near Nervesa. *A shell bursting over W/T station.*

the papers in a shell hole; these were ultimately recovered when we counter-attacked and regained the small loss of ground given under the first weight of the attack. It is interesting to note that one of the survivors succeeded in preventing himself being made prisoner by feigning death and remaining on his stomach in a shell hole for a considerable period. His companions in this shell hole were both dead, and this helped him in making his ruse good, but I believe a very unhappy quarter of an hour was spent, whilst Austrian parties were searching for wounded and passing their hands through his clothing for any spare "souvenirs" that were to be had.

After the enemy had been soundly trounced a period of inactivity was enforced, but we were kept fully occupied by enemy wireless which was not so much of a tactical nature as practice to keep their hands in, and they needed the latter badly. The operating was simply appalling, rarely, if ever, rising above five words a minute, and the style and formation beggars description. It was no uncommon thing for a message to be repeated at least half a dozen times and for the receiving station finally to give it up as a bad job. Whatever use such operators could be in a "show" such as in France one fails to see, and such inefficiency, I understand, was not confined to operating, but was found to exist in the apparatus itself. Many of the sets obtained their "juice" by means of a bicycle-driven generator and it was amusing to hear the note obtained. One could imagine the Austrian hard at work on his pedals; gradually the note would get higher and higher, but so slow was the operating that long ere the message was finished the pedaller was tired out and the note had dropped in pitch about half a dozen octaves. A long drawn out "gurr" often intervened, and finally the signals died out entirely, leaving the operator wondering how much, if any, the receiving station had got of his message; usually it was confined to the first two words. Furious requests would then be made for a repetition of the message

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and again the farce would start, intermingled with perhaps another two or three stations on the same game, until the interception operator in our lines would throw up the sponge, and leave them to fight it out. A nearer approach to Bedlam has yet to be conceived, I should imagine.

We were always on the look-out for enemy stations using continuous wave sets, but we never found them. Possibly, as they were not sufficiently trained for spark work the idea of giving the operators C.W. was out of the question, and therefore it was not instituted.

During August a rather alarming incident happened at one of our own stations. Atmospherics had been very heavy, and with our excellent amplifiers in use, they occasionally resembled machine gun fire, so that working was at times impossible. It was during one of these periods that a terrific thunder-storm took place and burst right overhead one of the stations, actually striking the aerial which was being earthed at the time. The bill of damages consisted of a 200 volt H.T. battery completely burnt out, two telephone transformers, two pairs of Brown's telephones, some condensers and a few valves. The set was earthed at the time and the aerial was disconnected from the set, yet due to its being isolated in the open it was struck. The hut was completely wrecked, the set put out of action, and all was in a chaotic condition, but luckily no one was inside at the time. This particular station was about 30 miles away from our Headquarters and the repairs were effected, the hut patched up, and the set again working, 24 hours after this incident happened.

Several distinguished visitors interested in wireless telegraphy visited the British Expeditionary Force in Italy, chief amongst these being Senatore Marconi. He inspected one of the stations at Malo and expressed his satisfaction at the work performed. Such praise coming from the great inventor was very welcome. Liaison work with the French Force in Italy, the Italian Army Section and the Supreme Command was very finely carried out, and Colonel Bardeloni of the Italian Army was enthusiastic in anything connected with wireless telegraphy. Early in October every one was working toward the offensive which was to be undertaken against the enemy, and in this respect wireless played a very big part. Every effort was made to locate the enemy stations and intercept as many enemy messages as possible, with excellent results. Positions of enemy wireless stations obtained by big Direction Finders were verified by photographs taken from aeroplanes and by other means, and when we opened the offensive I believe the complete battle order of the enemy was known to us. How well this offensive succeeded is ancient history; it was all over in about ten days. Much booty in the way of wireless gear fell into our hands, in fact we had an enormous dump of apparatus of every description, but very little of real use.

Lord Cavan, on a visit to the Wireless Headquarters, thanked the personnel for their work, and said how valuable it all was. The Chief of Intelligence wrote the following: "Let me "say how much I appreciate, too, the "good work and long diligence of all "your show in connection with Intelli- "gence; it has helped us a lot." At least one Military Cross, one D.C.M., one M.S.M., and mentions in despatches fell to the lot of wireless men in Italy during the twelve months' war they waged there. Such a record is one to be proud of.

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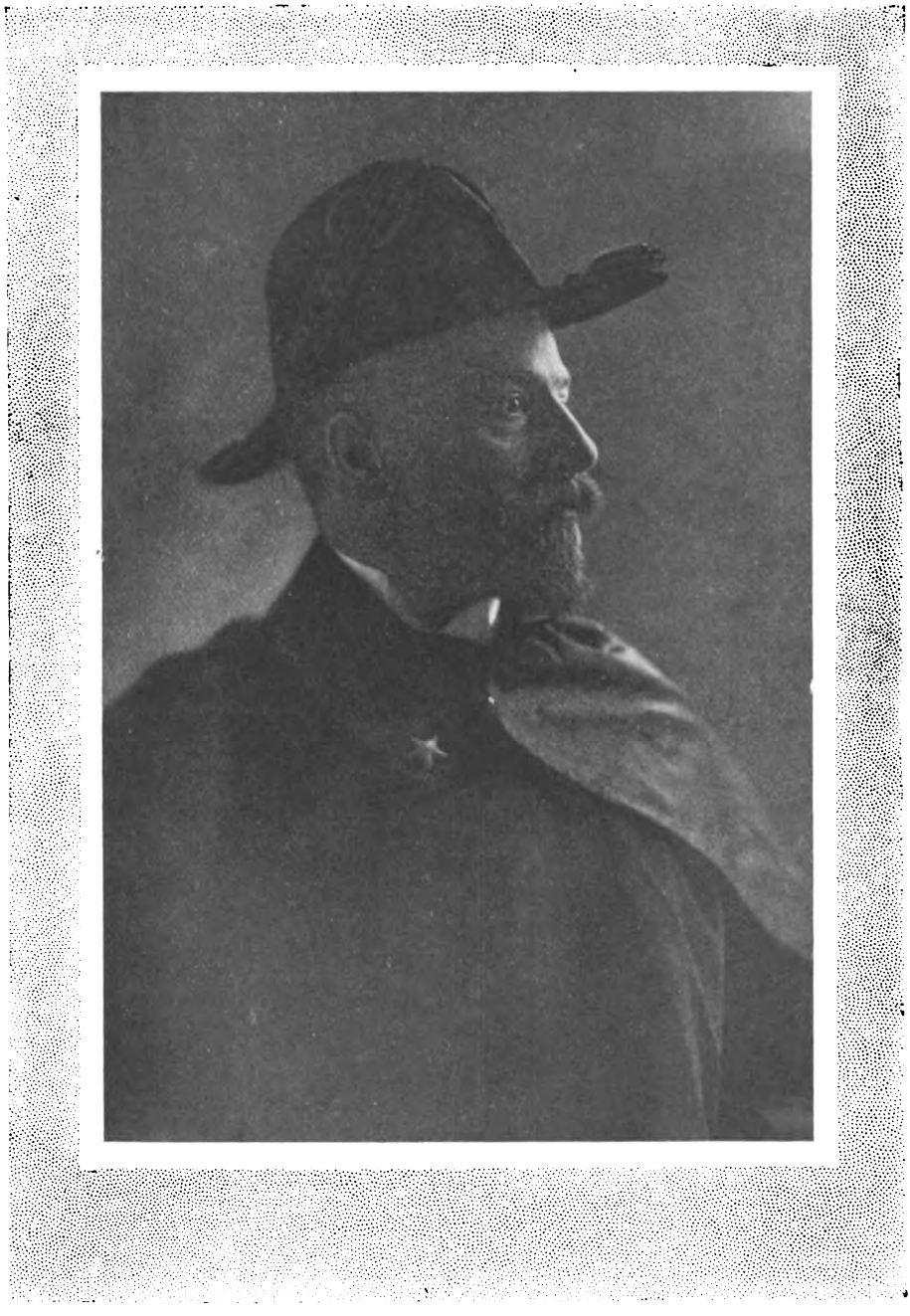

MARQUIS LUIGI SOLARI.

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Personalities in the Wireless World.

IN his early youth Marquis Luigi Solari chose the ways of the sea. Upon finishing his studies at the Royal Lyceum of Ancona and at the Cavallero Institute of Florence, where was also Senatore (then Mr.) Marconi he entered the Royal Naval Academy at Leghorn in 1887. Obtaining his commission in the Royal Italian Navy in 1892, after several voyages across the Atlantic and to the Near East, he was sent on a mission to China during the Boxer Revolution.

After travelling around the world he resumed the study of electricity, obtaining the diploma of Electrical Engineer at the University of Turin. Whilst at the Electrical Laboratory of the Royal Navy at Spezia he was called upon to conduct researches in wireless telegraphy and succeeded by means of apparatus constructed at Spezia in establishing wireless communications with Calvi (Corsica) and Biot (South of France). In view of these successful experiments the Marquis Solari did his utmost to bring about the widest application of wireless telegraphy in Italy.

He was in charge of the wireless station on board the battleship *Carlo Alberto* whilst the historical tests on board that vessel were being carried out under the direct supervision of Senatore Marconi. From the Mediterranean the *Carlo Alberto* went to Russia and thence to Canada being all the time in communication with the station at Poldhu. The Marquis Solari wrote the official detailed report of these experiments and, further, directed and superintended the erection of various wireless installations on board Italian warships, the first wireless stations in Rome and La Maddalena and the first international wireless line opened for public service between Bari (Italy) and Antivari (Montenegro). He was then asked to direct, under the supervision of Senatore Marconi, the erection of the high power station at Coltano (near Pisa).

As a delegate of the Italian Government the Marquis was at the Berlin Wireless Conference and at the International Congress of Electricity at St. Louis, where he read a paper on the history and progress of wireless telegraphy. For two years he was head of the Wireless Department of the Italian Ministry of Posts and Telegraphs. He was the promoter of the first applications of wireless telegraphy in China between Taku and Pekin.

In view of the necessity of developing the Marconi system in Southern Europe, and in order to combat the progress of the German system which was so strongly supported by the German Government for imperialistic purposes, the Marquis Solari for several years assisted in the conduct of negotiations with the Governments of Portugal, Spain, Serbia, Bulgaria, Roumania, Turkey and Greece, resulting in the introduction of the Marconi system into all these countries.

He now directs the wireless telegraph service on board the steamers of the Italian Merchant Marine, and is in charge of the Marconi Works at Genoa and the Marconi Office in Rome.

The Marquis Solari is a Commander of the Royal Italian Navy, is decorated with bronze medals for the campaigns of China and Africa and is a Cavaliere Ufficiale della Corona d'Italia, a Cavaliere dei SS. Maurizio e Lazzaro, a Commendatore of Danilo and a Cavaliere of St. Anna.

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The Theory of Valve Rectification

By W. S. Barrell.

(*Continued from July Number.*)

A NEW development in rectifiers might here be mentioned. In wireless telegraphy, as also in other electrical work, it is often necessary to rectify alternating current for some particular purpose. For example, it may be that a valve transmitter has been installed, and the only means of obtaining the necessary high tension voltage for the anode is an alternator and step-up transformer. If this were applied direct to the valve circuit undamped oscillations would not be radiated from the aerial. On the other hand, by inserting a high-power rectifier in one of the leads from the secondary of the transformer, the alternating current is rectified, direct current applied to the valve and continuous waves radiated from the aerial.

This high-power rectifier is essentially a large Fleming valve, having but two electrodes, filament and anode, the main points of difference from the receiving valve being in the design.

In the first place the size of the anode is an important factor. It must be of sufficient area to deal with the energy passing through the valve, as if too small it is liable to become excessively hot. On the other hand it should not be too large, as since all the metal in the valve must be devoid of any occluded gas, extra work is entailed in gas-freeing. Secondly, the vacuum must be of a very high order.

RECTIFICATION BY THE THREE-ELECTRODE VALVE.

The sensitiveness of a two-electrode or Fleming valve as a detector may be greatly increased by placing between the filament and anode a third electrode which is known as the grid. This may be either a metallic plate with a number of holes punched in it, a spiral or a wire network, the constructional details as to size, distance from filament and such like depending upon certain principles which need not be discussed in an elementary article of this nature.

It has already been shown that the number of electrons emitted from an incandescent filament depends upon its temperature increasing with an increase of temperature, and provided saturation is not reached the current through the valve will increase as the anode voltage increases. Again, any variation of potential in the path of the electron stream will cause a change to take place in the electron current.

The function of the grid, referred to above, at once becomes apparent, for if its potential be lower than than of the filament, that is to say, if the grid potential is negative with respect to the negative end of the filament, it will, since the electrons are also minute negative charges, tend to repel them and consequently reduce the current between the anode and the filament. The electrons will therefore congregate between the grid and filament setting up what is known as the space charge. Should the grid lose some of its negative charge the space charge will be reduced with an increase of current through the tube and the application of a positive potential to the grid will to a great extent neutralize the space charge with a still greater increase in anode current.

Langmuir has shown that in the three-electrode valve the plate cur-

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rent conforms very approximately to the formula:

$$I = A\,(V_a + \kappa V_g)^{\frac{3}{2}}$$

where I = Current in amperes
V_a = Voltage on the anode
V_g = Voltage on the grid

and A and κ are constants depending upon the geometrical design of the valve.

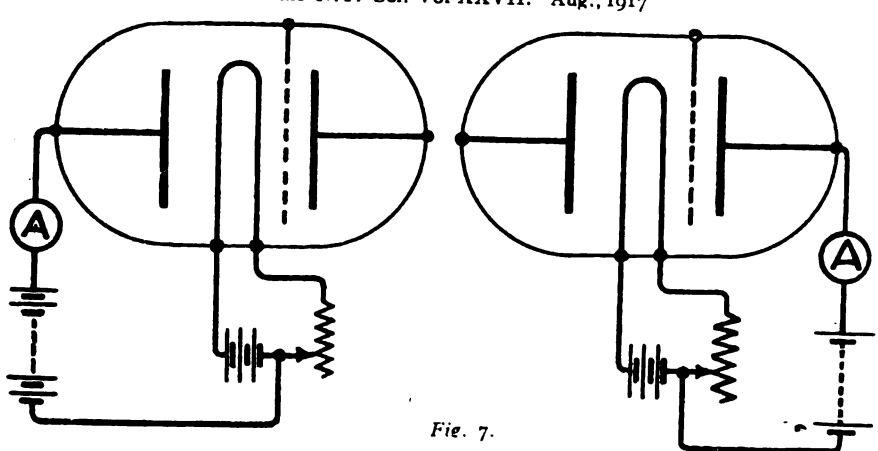
Very interesting experiments have been described by Armstrong* showing the effect of the grid in a valve. Special tubes were made having two independent anodes made in the form of flat plates placed parallel to each other and symmetrical with respect to the filament but having only one grid placed on one side of the filament as shown in Fig. 7, a and b. Under exactly similar conditions of high tension voltage and filament current it was found that a much greater current passed between the filament and anode in the case shown in Fig. 7a, that is when no grid was interposed between the anode and kathode. In both cases the grid was left quite free and with no connection whatever to any other part of the circuit. It seemed certain that in the case shown in Fig. 7b the grid opposed the flow of electronic current, and investigation showed: "That this was due to the charge accumulating on the grid when exposed to bombardment by the electrons passing from the filament to the plate." The electrons attach themselves to the grid giving it a powerful negative charge which impedes the flow of electrons from the filament to the anode, with a consequent reduction in current.

As in the case of the Fleming valve, the phenomena of the three-electrode type can be best understood by the study of a characteristic curve. As, however, the circuit and method for this have been fully treated in standard works it will not be repeated here, and the reader is referred to these works for full details.

It will be assumed, therefore, that a curve has been drawn which will be of the nature shown in Fig. 8.

Before passing to a detailed consideration of this curve, it should be noted that the general shape of these characteristic curves is practically always the same, although the exact position of the curve relative to the current and voltage axes may be very different in different circumstances. The curve is raised, for example, by increasing the anode or high tension voltage, or by reducing the number of turns per inch of the grid in

* Annals N.Y. Sci. Vol XXVII. Aug., 1917



a. b.

Fig. 7.

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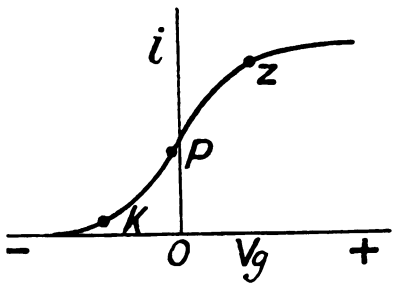

Fig. 8.

the case of a valve with a spiral grid. Hence it should be evident that the point at which the curve will cut the current (vertical) axis depends upon the above factors and other geometrical details of the tube.

The main difference in obtaining the characteristic curves of the two-electrode and three-electrode valves should be borne in mind, namely, that in the case of the former the current in the anode circuit is plotted against *anode* voltages, whereas in the case of the three-electrode valve with a fixed anode voltage, the current in that circuit is plotted against the voltages on the *grid*. Thus the voltage across the grid circuit controls the current flowing in the anode circuit.

A study of Fig. 8 shows that starting at, say, the point P an increase in grid voltage causes an increase, and a decrease in grid voltage causes a decrease, in the current in the anode circuit. This is the fundamental action of the valve.

It follows that if an alternating E.M.F. be impressed on the grid variations in anode current will ensue, the positive half-waves producing an increase and the negative half-waves a reduction. If then the potential of the grid be so adjusted that the valve is normally operating at the point P, Fig. 8, the oscillations in the grid circuit will be repeated in the anode circuit. These oscillations are of much too high frequency directly to affect the telephone receiver connected in the anode circuit, consequently the valve must be so adjusted that the effect of a whole group of oscillations impressed on the grid is transformed into one low frequency variation in the telephone current; that is, it must be rectified. This can be done by working the valve at one of the bends K or Z, Fig. 8, in a manner similar to that described with the Fleming valve.

In Fig. 9 is shown the arrangement for connecting the three-electrode valve to a simple circuit which should be compared with Fig. 3.

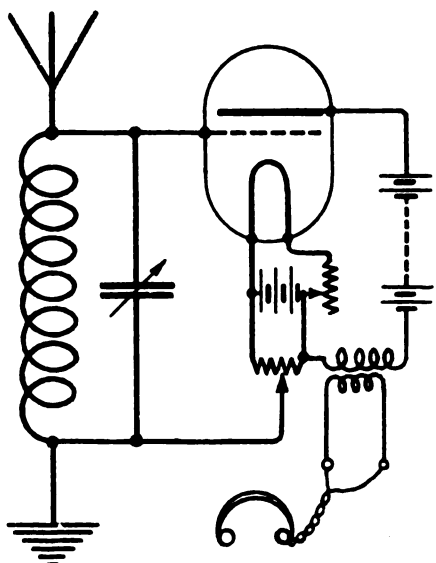

Fig. 9.

In this case it will be seen that the grid and filament are connected across the oscilatory circuits, constituting the control. By means of the potentiometer the normal potential of the grid is adjusted to the point K on the curve, Fig 8. By reason of the curvature of the characteristic the mean anode current is increased during the oscillations similar to that shown in Fig. 4 and fluctuations are obtained through the telephones having the same frequency as that of the spark at the transmitting station.

(To be continued.)

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Digest of Wireless Literature

HIGH FREQUENCY ALTERNATORS.

By M. LATOUR.

(Continued from July Number.)

THE homopolar type of the above machine possesses the advantage that the flux does not change its direction in the teeth of the rotor during rotation, so that from the point of view of the losses, all the advantages of the homopolar machine are thus secured.

Theoretically as there are no conductors in the stator slots, it should be possible to construct this machine for any frequency. In practice, however, it would be necessary to reduce the air gap proportionally to the size of the teeth which becomes impossible for mechanical reasons. If this reduction of the air gap is not effected the maximum and minimum reluctance of the magnetic circuit become sensibly equal.

These variable reluctance machines can give rise to a frequency multiplication similar to that obtained in the Goldschmidt machine having poles of alternate polarity. In this case, with a machine having all poles of the same sign, the windings become the seat of currents which may be represented by all the *odd and even* terms of the Fourier Series. From this point of view these machines should be able to yield the highest frequencies without excessive peripheral speed.

5. *ALTERNATORS UTILISING PART ONLY OF THE ARMATURE PERIPHERY.*

The difficulty encountered in constructing a machine either of the usual type with poles of alternate sign, or homopolar, for very high frequencies, without increasing the peripheral speed, resides in the practical impossibility of accommodating the windings in the slots. Thus with a peripheral speed of 150 metres per second, for 30,000 ~ the pole pitch is only 2.5 mms. Reserving 2 mms. for the thickness of the tooth, there is only 0.5 mm. for the slot.

It is, however, possible to imagine a machine having only a fraction of the required number of poles, and to combine together several machines so as to distribute the total number of poles between them. Thus in place of a single machine a system of three machines (I, II and III, Fig. 5) may be considered, in which the succession of the poles takes place by passing from one machine to the other, and by omitting two poles out of three on each machine. The space gained by the omission of these poles allows for the easier accommodation of the windings. Fig 5 represents the poles of the rotors of the three machines on the left, and the stators on the right. The first N pole is shown on Machine I, the following S pole on Machine II, the second N pole on Machine III., and the second S pole back again on the first machine, and so on. On each rotor two-thirds of the normal number of poles are omitted. On the

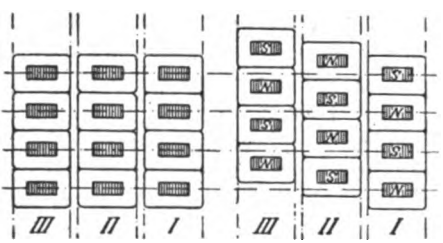

Fig. 5.

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three stators two teeth out of each three are also omitted as shown.

This method may be applied equally to the homopolar machines and to the variable impedance alternators that have been dealt with above. In these cases it is merely necessary that blank spaces should replace the poles of opposite sign. Fig. 6 illustrates the arrangement

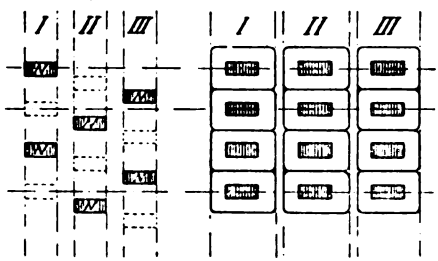

Fig. 6.

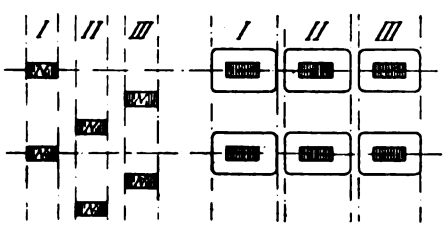

Fig. 7.

for a homopolar machine, and Fig. 7 that for a variable-reluctance alternator.

The author concludes by indicating that each machine of the above series really generates a fundamental frequency = 1/3rd the output frequency of the group, combined with a third harmonic; and shows that by combining the three machines into one frame the fundamental frequency is eliminated and the total losses consequently reduced.

VACUUM-TUBE AMPLIFIERS.

By LIEUT. M. C. BATSEL (SIGNAL CORPS, U.S.A.).

Electrical World, 73, p. 568 (March, 1919).

The most fundamental and most useful property of the vacuum tube is its ability to amplify alternating electrical currents, voltages or power. This amplifying ability arises from the fact that the power required to cause a given variation in the potential of the grid of a tube is less than the power associated with the resulting variations of the current in the plate circuit. The Signal Corps of the United States Army has made two important uses of vacuum-tube amplifiers, for the amplification of weak ground currents in the reception of earth conduction telegraph signals and the picking up of stray telephonic currents, and for the amplification of radio signals both at radio-frequency before being rectified by a detector and at audio-frequency after the radio-frequency signals are changed to an audible frequency by means of the detector.

Although a vacuum-tube amplifier in a sense, returns more energy than it receives, amplification does not violate the principle of the conservation of energy and does not literally give something for nothing. It may be likened to the action of an ordinary direct-current generator. An increase in the field current (or voltage) of the generator will cause a similar increase in the voltage produced by the armature and correspondingly in the load current. The increase in output will be much greater than the increase of power in the field circuit, but this added power is, of course, derived from mechanical forces which drive the generator shaft. In an analogous sense, the amplified power derived from a vacuum tube is obtained from the battery which supplies the plate voltage and current of the tube. In the generator the field voltage controls the output through the agency of a magnetic field. In the vacuum tube the grid voltage controls the output through the agency of an electric field.

When the grid of a tube is maintained at a mean potential more nega-

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tive than any part of the filament the only current which flows in it is a very small one due to leakage or gas ionization. Therefore the amount of power required to cause a given change in the grid potential is small. Since the vacuum tube operates by virtue of the potential difference established between the filament and the grid, it is desirable to transform the power supplied to as high a voltage as possible. If the source of voltage has an impedance Z_1, a transformer to supply current to the grid filament circuit should have a ratio K in the step-up sense such that $K^2 Z_1 = Z_2$, where Z_2 is the impedance of the grid filament circuit. The maximum power is then derived from the source of voltage, and the greatest possible potential difference established between the filament and the grid, resulting in the maximum power output from the tube. Such a transformer is known as an "input transformer," and its use with vacuum-tube amplifiers is almost universal. The combination of input transformer and tube is called one "stage" of amplification. Several stages may be connected in series or cascade, the plate circuit of one tube feeding into the primary of the input transformer of the next stage, and so on.

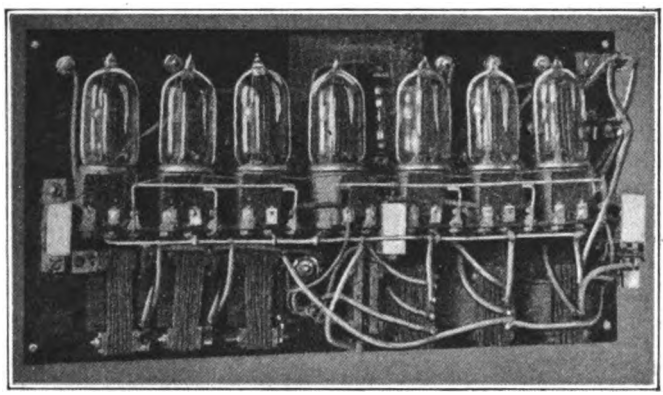

Fig. 1.

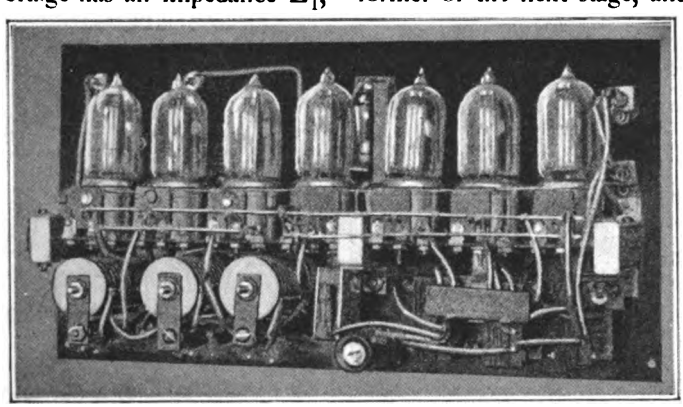

Fig. 2.

AUDIO-FREQUENCY AMPLIFIERS.

One of the first pieces of radio equipment manufactured for the U.S. army after the establishment of the radio development organization was the type SCR-72 two-stage audio-frequency amplifier designed and constructed by

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the Western Electric Company. Many hundreds of them were produced and have in service given excellent satisfaction.

There are no adjustments of any kind. Simplicity and reliability are the outstanding features. The power of the output signal is from 40,000 to 60,000 times that of the input signal.

If the signal to be received is weak and is masked by interfering noises of equal or greater loudness, it is found that amplification beyond a certain degree is detrimental. If the interfering noises are amplified to be louder than this rather critical value, the ear is overburdened and is unable to distinguish the signal as well as when both signal and interference are weaker.

The input transformer which was used in the SCR-72-B amplifiers and in certain other equipment which involved stages of amplification built in units, was designed and manufactured by the Western Electric Company. It is a shell-type transformer and its winding is composed of about 6,000 feet (1,830 m.) of No. 40 enamelled copper wire covered with a single layer of silk.

RADIO-FREQUENCY AMPLIFIERS.

The principal use to which these amplifiers have been so far applied is in connection with radio direction-finders. In this work the signals are generally so weak (since the amount of energy picked up by the small loop antenna is so meagre) that extremely high amplification must be employed. To build a reliable efficient amplifier of more than three stages, at any one frequency, is practically impossible, since very grave difficulties are met with in keeping it from howling or oscillating. It is, however, quite feasible to amplify a radio signal at its radio frequency, pass it through a detector tube and then amplify the resulting audio frequency current. This not only gives the increase due to both the radio and the audio-frequency amplifiers, but in addition increases the detector tube efficiency since, within limits, the efficiency of detection increases with the signal strength. Thus the receiver usually works out best in seven stages—three radio, one detector and three audio. Properly designed sets of this kind, operated non-oscillating and without regeneration, will give signals more than 10^{14} times as strong as would be obtained with a simple one-tube detector. By using a regenerative feed back much higher amplification can be realized, but the operation becomes less stable.

Of the several methods which may be used for transferring the output of the plate circuit of one tube of a radio-frequency amplifier to the input or grid circuit of the next tube, the iron-core input transformer has been most used. Air-core transformers have also been successfully utilized, but they result in a less stable unit. The core is made up of laminations of enamelled soft steel $1\frac{1}{2}$ mils. thick (0.38 mm.). The primary and secondary windings each consist of a single layer of No. 40 enamelled copper wire. The magnetic circuit contains a short air gap.

Figs. 1 and 2 show rear views of the panels of seven-stage radio-audio frequency amplifiers made up with iron and air-core radio frequency input transformers respectively. The three radio stages are on the left of the picture, the detector in the middle, and the audio stages on the right in each case. The tube sockets are carried on sponge rubber to reduce vibration. The other parts are carried directly on the panel. The two amplifiers are identical in outside appearance. The filament rheostat provides control of the degree of amplification, and no other adjustment is

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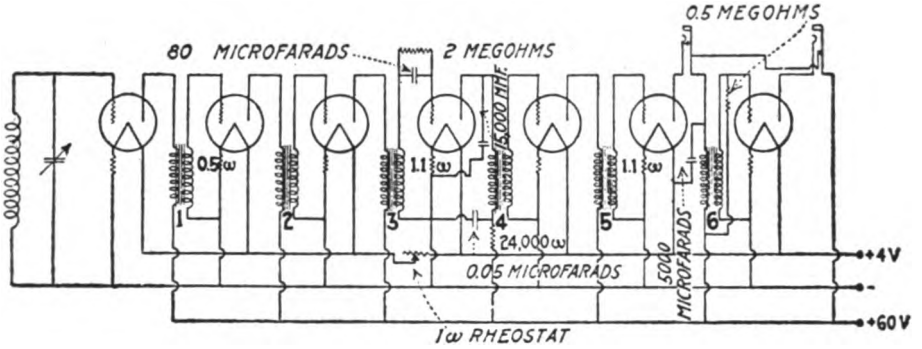

Fig. 3.

needed. The particular sets illustrated were designed for use in air-planes. Others of very similar appearance have been made for ground use. The circuit diagram is shown in Fig. 3. The batteries for supplying the plate current are contained in a separate box. It is desirable to have the box as small as possible because it is more convenient to mount several small boxes in an airplane than one large box. The plate battery consists of three standard 20-volt dry batteries in series. The filament battery must supply 7.7 amp. at 4 volts

The Amplification of Photo-Electric Currents.

A HINT TO RESEARCH WORKERS.

IN 1887 Hertz noticed that when rays of ultra-violet light fell on a spark-gap the electric discharge was facilitated, and Wiedemann and Ebert showed in 1888 that this action has its seat at the cathode. In the same year Hallwachs found that a negatively-charged body loses its charge when subjected to the action of ultra-violet light, whilst the same investigator and Professor Righi showed, independently of each other, that an insulated and electrically neutral body acquires a positive charge by the same means. It is now an established fact that æther-waves of a frequency corresponding to that of ultra-violet light will release electrons from metallic bodies. If, for example, a polished metal plate is connected to the negative terminal of a voltaic battery the positive terminal of which is connected to a perforated metal plate situated at a certain distance from the zinc plate, and the latter is brought under the influence of light from an electric spark, electric arc, or mercury vapour lamp, then it is possible to detect the passage of a current between the plates. Photo-electric cells have been constructed on this principle and a type evolved by J. Kunz and J. Kemp has been used by them as a receiver in wireless telegraphy. A paper by C. E. Pike, contributed to the *Physical Review** deals with the amplification of the photo-electric current by means of the three-electrode valve. The writer shows that such currents can be amplified by this means from 1600 to 5000 times, and that the weaker the light the smaller the primary photo-electric current and the larger the amplification. Further investigation of this problem may lead to results which would increase the value of the photo-electric cell as a detector and there still remains to continue the research with ultra-violet and interrupted light, with alternating currents.

* February, 1919.

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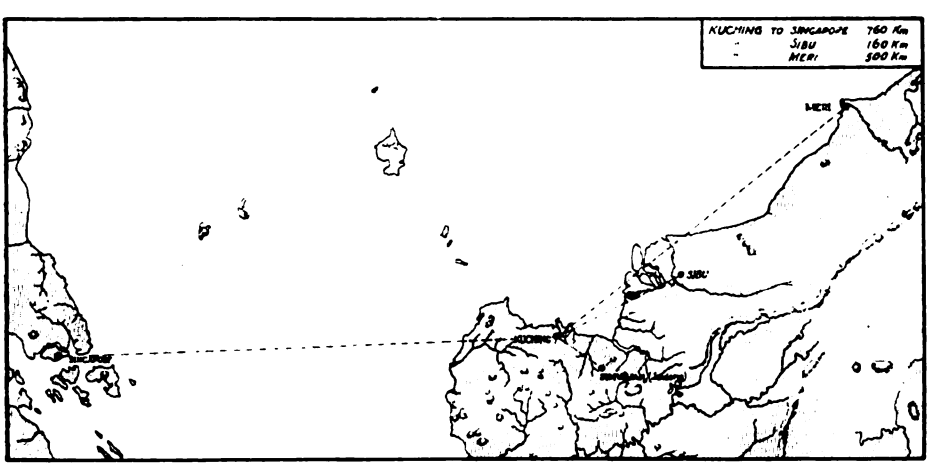
The New Wireless Service on the Island of Borneo.

By Jacques Boyer.

AFTER Australia and New Guinea, Borneo is the largest island in the world, but, in spite of its wealth in minerals, animals and forests, only 1,800,000 people inhabit its area of 735,000 square kilometres. The Dutch possess more than two-thirds of the island, whilst the other part of its territory, in the north-west, belongs to the English. In this latter-named region are first distinguished British Borneo, which comprises the possessions acquired from the Sultans of Brunei and of Sulu in 1879-80 (an area of 79,632 square kilometres), then the Kingdom of Sarawak (an area of 102,400 square kilometres with over 640 kilometres of sea coast) which has been under an English protectorate since 1888. The present white Rajah is named Brooke and is the descendant of a London family. He succeeded his father in May, 1917. Under the control of the British Government he exercises authority over a population of various races, estimated at 600,000 inhabitants.

The special feature, however, which alone interests us in this article, is that the Indo-Malay Archipelago did not possess up to last year any radiotelegraph station. Furthermore, in view of the difficulty of maintaining cables in tropical waters, ordinary telegraphy could not have been utilised without incurring expenditure out of proportion to the traffic over the line which would have connected Borneo with Singapore, which is situated at a distance of about two days and a half by sea. One cargo boat alone, a vessel of 1,500 tons, maintained the postal service and the transport of travellers and goods in both



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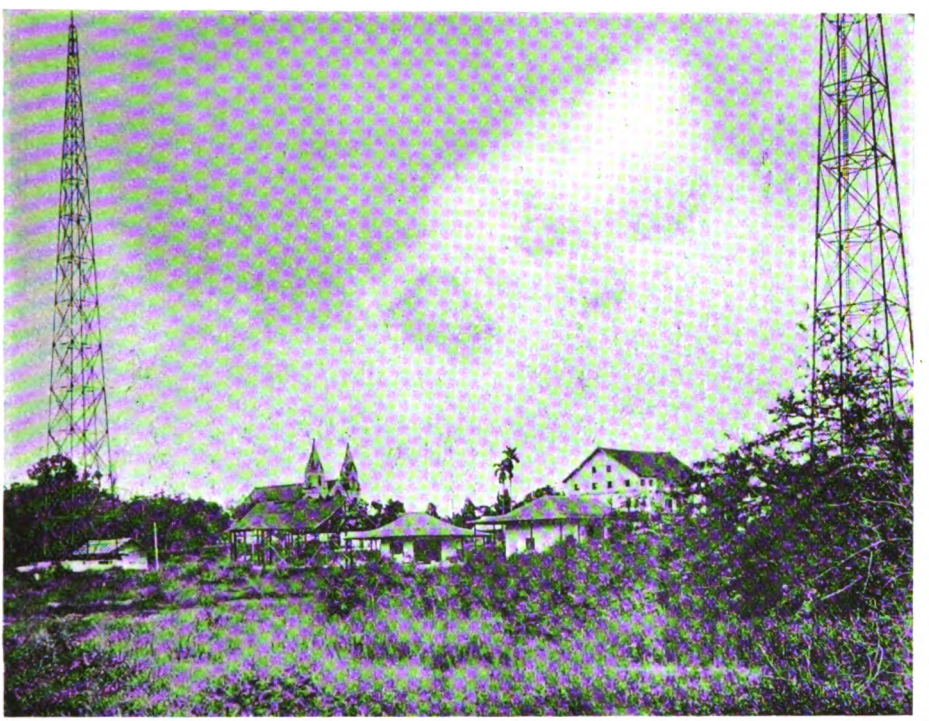
directions. The Island was therefore isolated for a part of the week. Even before the war the Rajah recognised the necessity of establishing a wireless service in his dominions. It was therefore decided to install a station in the capital, Kuching, a commercial town of 40,000 inhabitants, principally Chinese, and to supplement this station by three others of less importance at the surrounding districts. Lastly Simunjan, on the river Sadong, whose waters are greatly feared by Captains of vessels on account of the eddy, is a port through which pass annually 30,000 tons of coal obtained from the mines in the district.

The English Government charged the Anglo-French Wireless Limited, a branch of the Compagnie Générale de Radiotélégraphie Francaise (C.G.R.)



General view of the Kuching Station.

Meri, at Sibu, and at Simunjan respectively. The first of these little towns is situated towards the eastern part of the possession in which are found the petroleum layers belonging to the Anglo-Saxon Petroleum Company. Sibu, situated 60 miles up the river Regang, one of the most important in Sarawak, has a Dyak population and vast plantations of rubber are present in whose patents it was working within the British Empire, to install the system. Unfortunately hostilities suspended the realisation of the enterprise. However, the submarine war having revealed the desirability for rapid communications with Singapore and with Allied vessels navigating in these waters, on account of the pirates which infested the Malay Archipelago, the Rajah of

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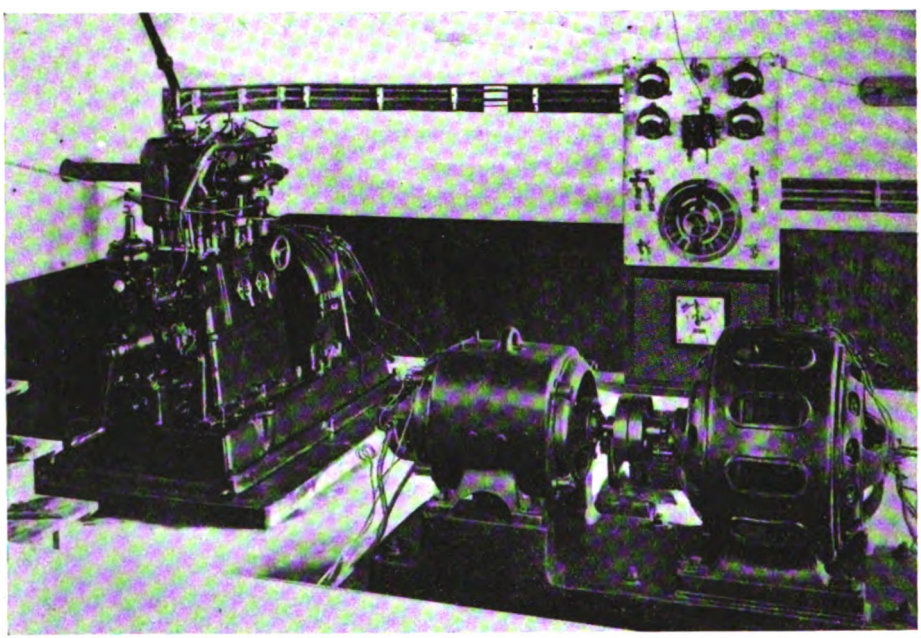
Borneo insisted on the immediate construction of the radiotelegraphic system projected for Sarawak. Now, the Anglo Wireless having disappeared in the interval, the C.G.R. despatched a technical mission to Borneo, which mission between May, 1916, and June, 1917, succeeded in erecting four wireless stations which we are now about to describe.

Each of these stations comprises a petrol motor generating group charging a battery of accumulators. The latter feeds a converter group producing the alternating current, of 500 periods, of the oscillatory circuit. The spark corresponding to the sound of about 1,000 vibrations per second is a suitable note for piercing the parasitic sounds which are so numerous in the tropics.

In all stations of Sarawak, the antenna, as is shown by our photographs, is supported by two square-based metal girder poles which, in their turn, support two small wooden masts of a height of 10 metres to which are fixed the terminal yards. The antennæ are of the so-called T-type, excepting that of the less important station of Simunjan, which has two wooden masts 30 metres high which were constructed on the spot.

Let us now enter into a few details concerning the engines and apparatus of the Kuching station. Its generating group can supply 118 amperes at 110 volts or 81 amperes at 160 volts. It is charged through the intermediary of a switch board fitted with automatic circuit-breakers. It further includes a battery commutator switch and a battery of accumulators of 60 elements, giving 800 ampere-hours. The converter group which is controlled from the operating room comprises a D.C. motor, coupled to an alternator of



The power plant at Kuching.

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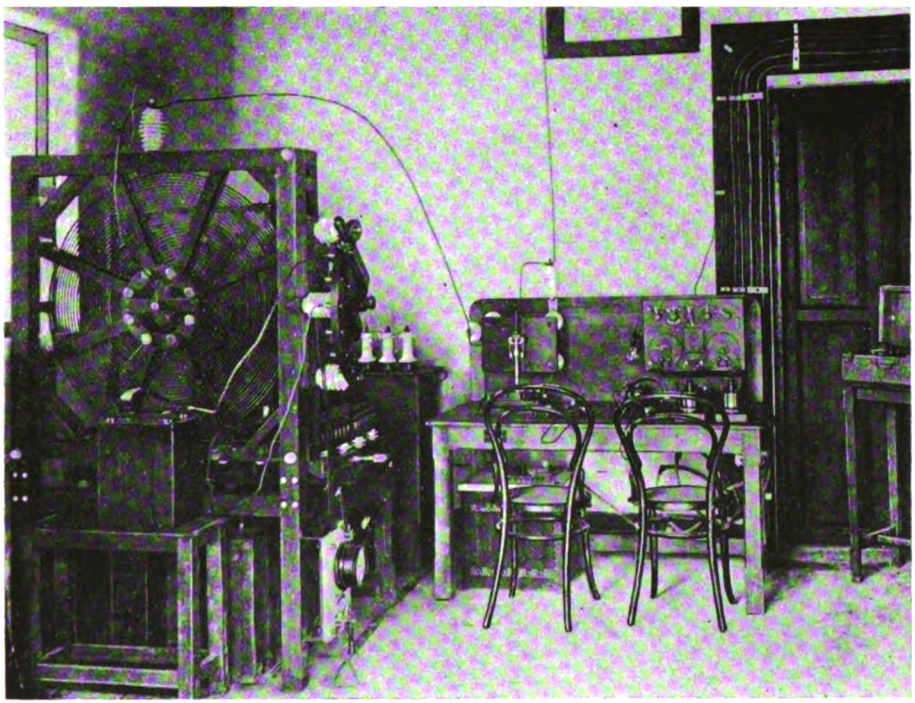
500 periods, capable of giving eight kilowatts. The transmitting apparatus is of the well known "C.G.R." type, with 56 adjustable spark gaps in series. The capacity used is 200 micro-micro-farads. On the whole the transmission apparatus of Kuching resembles that in use on board French armoured cruisers.

For reception a variable coupling is employed and in view of its extremely reduced damping this system permits

1,800 metres. At the outset, transmissions were also made on a 600 metre wave, by inserting a condenser in the antenna, when it was only desired to work with Simunjan. Afterwards a wave of 1,800 metres was uniformly adopted, experience having shown that this wavelength was the most suitable for the daylight traffic performed by the stations of Sarawak, which were all closed during the night. Very good



Operating Room at Kuching.

of very sharp tuning which is indispensable for a radiotelegraph station in the tropics. The two metal lattice poles, bearing the aerial, measure 75 metres and two small masts of 10 metres surmount them. This antenna, the spread of which is 102 metres, is composed of five wires supported by yards of 10·5 metres.

The length of the wave provided for long-distance communications is

signals were obtained at Singapore from Kuching, using a continuous current power input of only 60 amperes at 110 volts.

As the accompanying photographs reveal, the Engineer of the C.G.R. resorted exclusively to the services of the Malays, who were recruited on the spot and did not receive special training, for the erection of the masts of Kuching, Meri,

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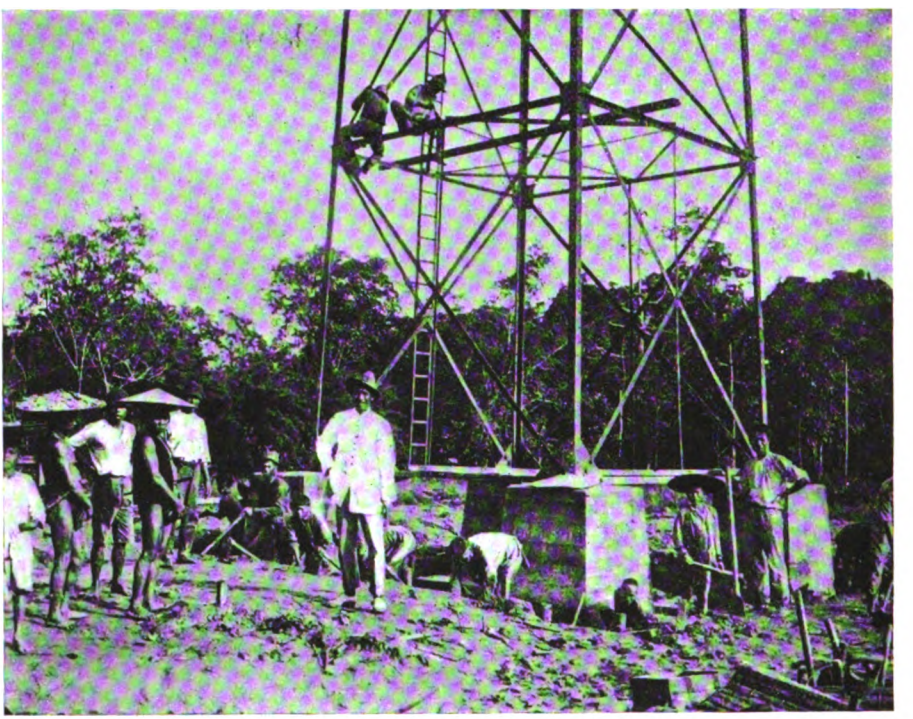
Sibu and Simunjan. Each race, moreover, shared the various tasks to be accomplished. The Dyaks, incomparable for work in the jungle, undertook the clearing of the ground for the sites. The Tamil Indians executed the ballastings and the concreting of the foundations. They set to work in the following manner in the erection of each mast. After having constructed a caisson on the site selected so as to form an empty space in the centre of the concrete block, they afterwards placed there one of the metal feet of the mast which they afterwards sealed. They then ran around the feet of the mast a counterweight of cement in order to avoid the ground heaping up. Next, Chinese workers erected the buildings of stone and wood.

The stations of Meri and of Sibu do not differ in principle from that of Kuching but their power is only four kilowatts. The masts of the first are 60 metres in height plus a small wooden mast of ten metres, whilst those of Sibu are ten metres less.

The following are the distances which separate the stations of Sarawak from Singapore and from each other:



Building a mast.

Distance from Kuching to Singapore—760 kilometres.

Distance from Kuching to Meri—500 kilometres.

Distance from Kuching to Sibu—160 kilometres.

The stations of Meri and of Sibu, situated near the coast, can communicate between themselves or direct with

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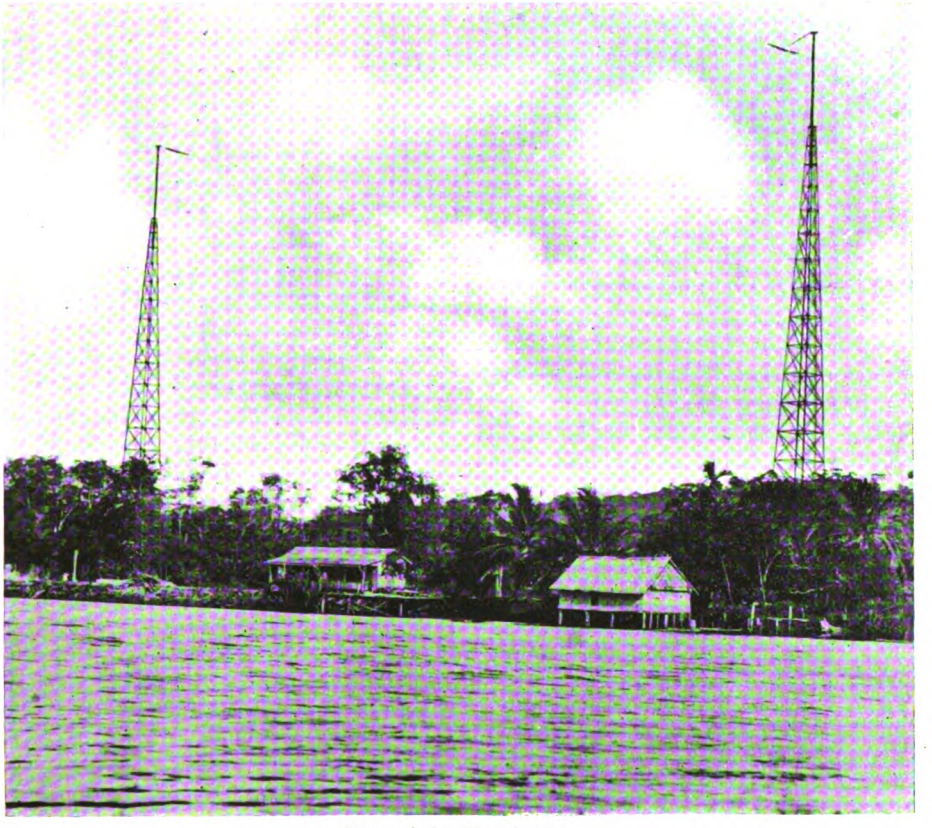

View of the Meri Station.

Singapore. However, for reasons of service the various stations of Borneo send their radiotelegrams through the medium of Kuching, exceptional cases apart. Their traffic is considerable as, apart from government telegrams, the messages sent by English merchants in rubber, gutta-percha, pepper and tan derived from mangroves, are amply sufficient to keep them going. Kuching sends every day at 8 a.m. (Singapore time) the time signals for the use of all the other wireless stations of the Island whose commercial work is carried on between 9 a.m. and 2 p.m., which is the most favourable time from the point of view of atmospheric conditions. Let us add by way of conclusion that the installation of this wireless system, whilst the war was in full progress, and having regard to the local difficulties to be overcome, does the greatest honour to the French technicians who carried out the operations so successfully.

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Stray Waves.

THE AMATEUR POSITION.

THE nose of the Hun has now been delicately adjusted to the grindstone, although the lock-nuts have not yet been tightened up. In other words, peace has been signed, but up to the time of writing not ratified. We now look forward to a proof that a state of war no longer exists—we do not count the small fry, Bulgaria and Co., or the war which flickers along the north-western frontier of India—in the shape of a speedy abolition of the more nauseous clauses of D.O.R.A., amongst which prominently figure those relating to the practice of radiotelegraphy by amateurs.

We are able to state that the authorities, fully mindful of what is expected of them, have already devoted a considerable amount of time to the question of private wireless working and that as soon as general conditions permit their decision will be put into execution. Last month we warned our readers that the Postmaster-General is confronted with a situation vastly different to that which existed before the outbreak of the late unpleasantness on the Continent, because of the fact that now most amateurs want to use three-electrode valves, not only for reception but for transmission also, and as we pointed out, the valve is, after the early American amateur, one of the most perfect "jamming" devices ever invented, that is, if badly manipulated. Therefore some distinction will probably have to be drawn between those applicants who are highly-skilled in the use of valves and have some serious work on hand, and those to whom the valve is simply a charming new toy which can be made to whistle, and shout the Parisian time-signals all over the room. The thought of fifty valves, all oscillating unknown to their owners, "howling" in "fifty different sharps and flats," all less than five miles from a wireless telephone station or a research laboratory, is disturbing enough to make a professional worker put 200 v. on the grid.

There is no doubt but that the government will cheerfully extend the fullest possible facilities to competent and responsible people who, though professional wireless men in war time, become amateurs in peace, and to all who are judged likely to respect official and commercial rights.

D. F. APPARATUS ON AEROPLANES.

A. S. Blatterman in the *Electrical World* describes the D.F. apparatus designed for the large Handley-Page machine. The Handley-Page apparatus is provided with two distinct sets of loops; one is mounted rigidly on the struts of the wings of the planes, a main coil fore and aft and an auxiliary coil athwartships. These coils are sewed into a canvas band about six inches wide, and cemented to the struts and the entering edges of the planes. They are used for straight homing flying. A similar set about 3 feet square is mounted inside the fuselage of the aeroplane in such a manner that it can be rotated about a vertical axis by a disc and pulley device. By means of this set of coils and a graduated dial the line of one of the land beacon stations can be taken, and if two such readings are obtained quickly at different

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stations, the location of the aeroplane can be determined. When the fixed winged coils are used it is necessary to alter the course in order to make the direction set, the latter being on the maximum signal and not on the minimum signal or zero signal as in ground D.F. work. The accuracy obtainable with this apparatus is about ± 1°.

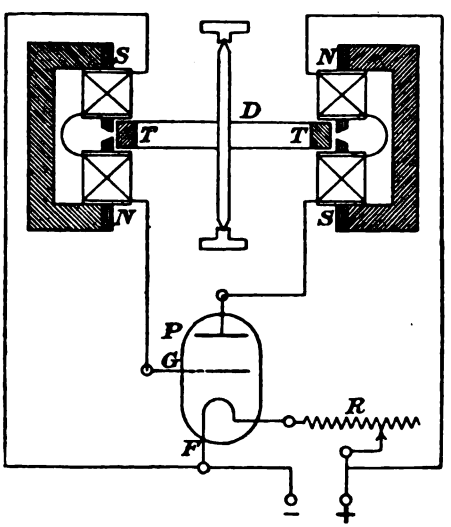
GERMAN WIRELESS ACTIVITY.

From the *Jahrbuch der Drahtlosen Telegraphie* we learn that the Wireless Telegraphy Research Department is again in full swing. At a meeting held in December, 1918, the agenda included the preparation of lists of names of persons who have been occupied on scientific and technical work in wireless telegraphy during the war, the determination of the state of their investigations, the collection of reports and patents originated during the war, the continuation of the work begun, and methods of using available apparatus. The Department was requested to take charge of all documents and apparatus, to avoid the loss of scientific information that had been obtained, and the publication mentioned was requested to publish a list of secret patents and important foreign patents with explanatory notes. In some things the German way is excellent and this prompt, organised gathering together of scientific assets is an undoubted sign that our late opponents are still to be reckoned with in the world of wireless work.

D.C. MOTOR USING THERMIONIC TUBES INSTEAD OF SLIDING CONTACTS.

We publish herewith the complete paper on the above subject due to W. H. Eccles, D.Sc., and F. W. Jordan, B.Sc., which was read before the Physical Society of London.

In physical laboratories, especially those in which electric waves and oscillations are studied, circumstances sometimes arise in which a wheel or disc has to be spun rapidly under light load and with absolute freedom from the sparking that occurs in the best ordinary direct-current motor. In such cases a motor employing a rotating magnetic field can be used if alternating current is available, but often alternating current is not at hand. We therefore describe in this paper a small perfectly sparkless motor that can be run from a direct-current supply, such as that used for lighting. Apart from the applications alluded to, this new motor might be used for maintaining gyrostats in rotation, for driving stroboscopes, and so on.



The motor is an application of the three-electrode ionic relay now so well known. In such relays there is a glowing filament F functioning as cathode, a plate or cylinder P as anode, and an intervening grid G as control electrode. A constant E.M.F. is applied between filament F and anode P and causes a steady stream of electrons to pass from filament to anode across the vacuum.

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When a control voltage is applied between filament and grid the anode current increases if the grid is made positive relative to the filament, and it diminishes if the grid is made negative. Either terminal of the filament may be taken as the zero of potential, but it is customary to take the negative terminal. For instance, in the small tubes shown with the motor, the anode current may be about 1.5 milliamperes when the grid is at the same potential as the negative terminal of the filament, and 2.5 milliamperes when the grid is at + 5 volts and 0.4 milliampere when the grid is at − 5 volts. The current flowing into the grid in the former case is 150 microamperes and in the latter zero. When an alternating voltage is applied to the control electrode an alternating current appears in the anode or repeat circuit superposed upon the steady current that flows in the quiescent state. This alternating current is capable of doing work, and the power thus made available is much greater than that expended in the control circuit—a fact implied in calling the tube a relay.

In the motor to be described a number of iron teeth are carried by the rotating part of the motor past an electromagnet connected into the control circuit of the ionic relay, and these teeth generate in the windings of the electromagnet an alternating E.M.F. that is applied to the grid of the tube. The corresponding alternating current in the repeat circuit is sent through a second electromagnet connected in that circuit and also placed near the rotor. Its position relative to the former electromagnet and to the teeth is so adjusted that the alternating current in it tends to accelerate the movement of the rotor. Put briefly, we may say that the passage of an iron tooth in front of the control magnet applies to the grid an E.M.F. that produces, by means of the relay, a current in the second electromagnet in such a direction as to pull forward the tooth just approaching it. In consequence the spin of the rotor increases until frictional and other losses consume all the energy liberated from the battery in the anode circuit.

Obviously a motor constructed on these principles may take many different forms. In the one sketched in the figure, the rotor is a horizontal ebonite disc 12 cm. in diameter mounted on a vertical spindle; the electromagnets are the polarised magnets from a pair of 4,000 ohm. Brown telephone receivers. The iron teeth are twelve in number and fixed at equal distances on the rim of the ebonite disc.

"BEAT" RECEPTION OF INSECTS' SOUNDS.

It is fairly well known that the human ear is sensitive only to waves of frequencies between about 30 and 25,000, and that therefore sounds produced by air disturbances at higher or lower frequencies are inaudible to us, though in certain cases the physical effect of the vibration can be felt. The ear, as a detector, may be said to have "flat" tuning, being operative only over a limited range. Bats and certain insects are said to emit sounds which are much too high pitched for us to be sensible of them, and a writer in the *English Mechanic* puts forward the suggestion that by means of employing the well-known "beat" method of wireless telegraphy this disability may be overcome. To entomologists this experiment should prove of considerable interest, but for ourselves, having chicken-keeping neighbours, we have no desire to eavesdrop on beetles and butterflies. Providence obviously intended us to be deaf to certain noises—and we presume to agree with the proposition.

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"W/T. R.E."

An Account of the Work and Development of Field Wireless Sets with the Armies in France.

By Capt. B. F. J. Schonland, O.B.E., R.E., late Staff Officer (Wireless) 1st Army, France.

(*Continued from July Number.*)

THE village of Paschaendale has a commanding view of the country on the Roulers Plain below it, and our possession of the village and ridge in December, 1917, made things very uncomfortable for the Boche. Unfortunately the country on our side of the ridge was, as is well known the most terrible slough, quagmire and quicksand that has ever existed. To lay cable above ground was useless, as it was cut by enemy fire as soon as laid, so a "C.W" wireless set was installed in Paschaendale village and from a tiny aerial kept in communication with Ypres, eleven kilometres away. In spite of very heavy shelling it gave prompt information of targets for the artillery for many days. Eventually the whole set was blown up by a shell. A new one was installed a little way back, and the same communication kept up. The work of this set was invaluable.

In the first battle of Cambrai, November, 1917, our sudden attack with Tanks took the enemy completely by surprise. Wireless sets were carried forward in some of the Tanks and then removed, small masts erected and good communication obtained with their "base." The advance was so rapid that the sets with infantry battalions and brigades had a big start over the telephone communications. Though lines for the latter were laid at a "gallop" once the trench system was crossed, for several hours the B.F. sets did the necessary transmission of situation reports and orders. The enemy's sudden counter-blow on November 29th resulted in the cutting of the main trunk telegraph and telephone lines between the two army corps affected, within a few hours of the first attack. As a consequence the wireless stations in the sector had a very busy time. Not only were they flooded with traffic, but they had constantly to retire and to re-erect their stations. The experience gained by all concerned, in the way of traffic disposal and regulation under conditions of abnormal pressure, was great. It led to changes in organisation which were felt the following year, when such cases of traffic "flooding" the stations were of almost daily occurrence.

No mention has so far been made of the Power-Buzzer, an instrument which we adopted from the French and later improved. In some respects hardly a "wireless" set—for it was part of a method of signalling by conduction through the earth—this, too, was manned and run by the wireless sections. It may shortly be described as an induction-coil "buzzing" a current into the earth by means of two earth-pins a hundred yards or less apart, connected to the coil by well-insulated cable. This buzzed current spreading out along the earth's surface was picked up by two similar earth-pins connected to a three-valve amplifier. As the Power-Buzzer required no aerial wires

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and could work over a range of from one to three thousand yards it was much used for the very forward infantry communications over areas where the enemy's barrage fire was intense. Its working was, of course, affected by the nature of the country between it and the amplifier. Owing to its extreme simplicity, portability, and the ease with which the length of cable could be repaired if broken, the Power-Buzzer was very successful in trench-warfare. It was often carried over with the second wave of attacking infantry, both for raids and for actual attacks. It could always be found in a hole near or in the front line, sometimes in a forward post in front of the front line; a hole dignified by the name of dug-out, that served the operator for shelter, bedroom, dining-room, office, and home generally.

Like the B.F. set, the Power-Buzzer was in every attack in 1917, though still nearer the enemy—so near that a story is told of a German who seized one of the earth-pins during a fight and remained fixed to the spot, earth-pin glued to his hand, while the operator kept his key pressed and another disarmed him! Even the mud of Flanders, though restricting the range, could not prevent the Power-Buzzer from saving the forward communications of the Naval Division in the battle of Ypres. Some idea of the small distances involved in such work, distances which could be covered in no other way may be gathered from the case of the Power-Buzzer in Bullecourt in May, 1917. Bullecourt, as readers may remember, was the high-water mark of the 1st Battle of Arras, and round this little village raged one of the most furious struggles the war produced. Even after the enemy's direct attacks had ceased he kept shelling it all day and all night. Communication with the village was well-nigh impossible over one stretch of five hundred yards. This stretch was spanned for several weeks by a Power-Buzzer installed in a dug-out in the village. The earth-pins were some fourteen yards apart, also in the dug-out.

This narrative has now been brought up to the close of the year 1917. The probationary or at least the youthful stage of the development of the W/T section R.E. was over at the end of that year. As I have tried to show, it had gradually grown from nothing to an organisation which was proving daily of incalculable value to the fighting troops. In spite of prejudice and difficulties, it was now plain that the salvation of forward communication in battle lay in wireless telegraphy.

My account of the work of wireless with the Signal Service in France must now be continued for the year 1918. The reader will have seen how, from a small beginning, a large organisation had sprung up. Great expectations were entertained of the work this organisation would do in 1918. That these were justified the sequel will show. During the winter of 1917-1918 the training of officers and men in the sets was brought to a very high pitch of efficiency, while the sets themselves were improved and increased in number and in power. The experience already gained in battle led to the design and production in large quantities of a number of new types of forward sets, notably a special pattern of continuous wave set and a very small portable spark set, known as the "loop" set. Events showed that sets could not be produced fast enough, so great was the demand during the epic fighting of the last year of the war.

The opening of the year brought with it the proud German boast of their great offensive which was to drive the Allies into the sea. In the mists of

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the morning of March 21st the expected attack from the Hindenburg line took place. Thanks to his elaborate preparations which included the provision of many light motor wireless sets the enemy succeeded in driving us back to within a few miles of Amiens. His wireless sets were working day and night, a veritable wireless "barrage," but our own were by no means idle. In spite of inevitable disorganisation, the difficulties of keeping accumulators charged, etc., our sets were everywhere of great value. One incident in the retirement should be historic. A battalion of the 37th Division, at Epinedes-Dallon, near St. Quentin, was ordered to cover the retirement of the division, and supplied with a trench set with which to keep in touch with headquarters. The battalion bravely did its work, though eventually surrounded by overwhelming odds. They held out until a message was received from the divisional general, thanking them for this great stand, whereby the retirement of the remainder had been safely accomplished. Back came their reply, "Goodbye, we are going to fight our way out."

After his attack further north and his suicidal attempt to take Paris, the tide turned against the Boche. The fourth British army in front of Amiens caught the enemy napping. The way wireless was used to "camouflage" our attack I hope to mention later. Our advance, owing to secrecy and careful preparation, was swift. The wireless sections of divisions, corps and armies were ready for a speedy advance, and had an enormous amount of traffic to deal with. One station, for example, dealt with 1,100 messages in six days, most of which messages had to be coded and de-coded. The pack-sets and motor wireless sections with the cavalry had work in plenty. Captured enemy wireless sets became a drug on the market!

So the advance went on until three armies, the First, Third and Fourth were "going over the top" together. The story of their advance is well-known—how the First Army pushed forward to Cambrai, turning the enemy's flank while the two armies below fought their way to the Hindenburg line, broke through it, and pushed on. What was "Sparks" doing all this time? The answer is best given by the two maps reproduced herewith. The first shows the distribution of spark sets and Power Buzzers on the First Army front just prior to the August offensive. I have not included the continuous wave artillery wireless system in this, for fear of complicating it. In the second map, which shows the same front after the offensive had started I have included the continuous wave system on a part only of the front. The reader will realise that the efficient working and control of so many stations in such a small area was a big problem. "Sparks," as you see, was busy! But he got busier still as the advance went on. Through Cambrai, St. Quentin, Douai, still we pushed on, faster and faster until the last few weeks when Lille, Valenciennes, Roulers, Mons, and Maubeuge saw our victorious troops.

As the advance quickened its pace it became more and more difficult to maintain even the most vital telegraphic communications with the troops. The Germans in their retreat had in most cases wrecked their own elaborate system of telegraph routes. Where the routes were not wrecked the wires were often touched with acid, and the poles carefully sawn half through. These little tricks of the wily Hun often gave trouble, while his habit of blowing up cross-roads and flooding the country by the destruction of locks and dykes

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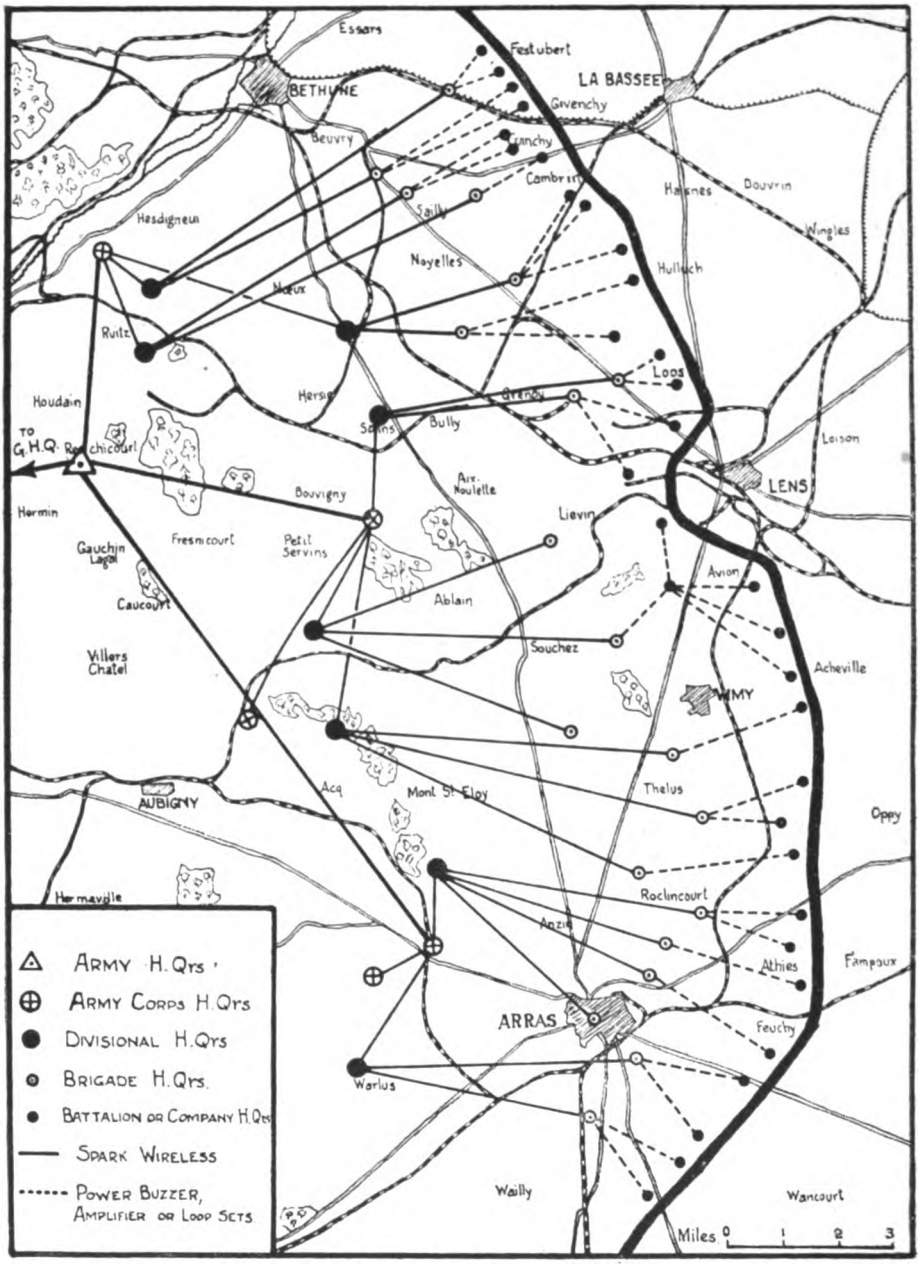

The First Army front just prior to the great offensive of August, 1918.

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made the motor-cyclist despatch rider's life a most unhappy one.

A detailed account of the work of wireless in the last months of the war would be a very big undertaking. The number of sets was then enormous, and new sets arrived daily from England, only to be swallowed up immediately. Besides the spark system—the "B.F." Sets, "loop" sets, Power-Buzzers, more powerful "Wilson" Transmitters and Mk. III Tuners, and the 1½ k.w. sets at army headquarters—which was working hard everywhere, the continuous wave system was of incalculable value to artillery and other units. I can only quote some typical instances. I have referred to the "loop" set, a very small portable spark set produced in 1918 for forward work. Once our rate of advance reached from three to six miles a day, the Power-Buzzer with its smaller range was put aside, and the most forward link in the wireless chain was filled by this little set. The supply of sets at the time of the armistice had not sufficed to equip all divisions fully in this respect, but some of these tiny sets were dealing with sixty to eighty messages a day in forward positions, such as company to battalion headquarters.

The B.F. sets with brigades and division did what was expected of them. That is to say they were often at it day and night without a rest, transmitting and receiving orders for future attacks, sending back reports of attacks in progress, ordering ammunition and supplies, and generally taking the traffic while lines were being repaired. Even the spark sets at army corps and army headquarters, whose work was usually of a control nature, to stop jamming and to see that no information was divulged by careless operating, had their chance. The difficulties involved in the maintenance of line communication and despatch-rider services, which I have touched on above, though wonderfully overcome in most cases, meant that it was not uncommon for a batch of thirty or forty messages to be sent from the signal (telegraph) office to the wireless station for transmission. The writer remembers one evening when an army corps had a dozen messages for its divisions, all concerned with an attack which was ordered by one of the messages for the following morning. To get messages to the divisions by line telegraph was impossible all lines were "down." Bridges too were "down," and to add to the difficulty the divisions had moved forward. To find them by despatch-riders in the darkness and with roads and bridges blown up was a hopeless proposition. So the corps wireless station started up and called its divisional stations. They all replied when called, and the messages were safely despatched, all other traffic ceasing till the "S.O.'s." (Urgent Operations Priority) had been duly acknowledged. The attack next day caused the fall of Valenciennes. The efficient working of the spark wireless system meant a great deal at such a time; thanks to the work of the personnel concerned, to organisation, and to careful preparation, it never failed.

Continuous wave sets with the "gunners" were in use with both heavy and field artillery. If difficulty was experienced in laying and maintaining telegraph lines for infantry "command" purposes, the difficulty here was still more acute. The cry from the artillery was for more C.W. sets, and still more! With the Forward Observation Officer in his O.P., with the guns themselves or with the headquarters of the artillery brigade, the valves of the C.W. sets were flickering night and day, and that their success was great is beyond any doubt. One divisional ar-

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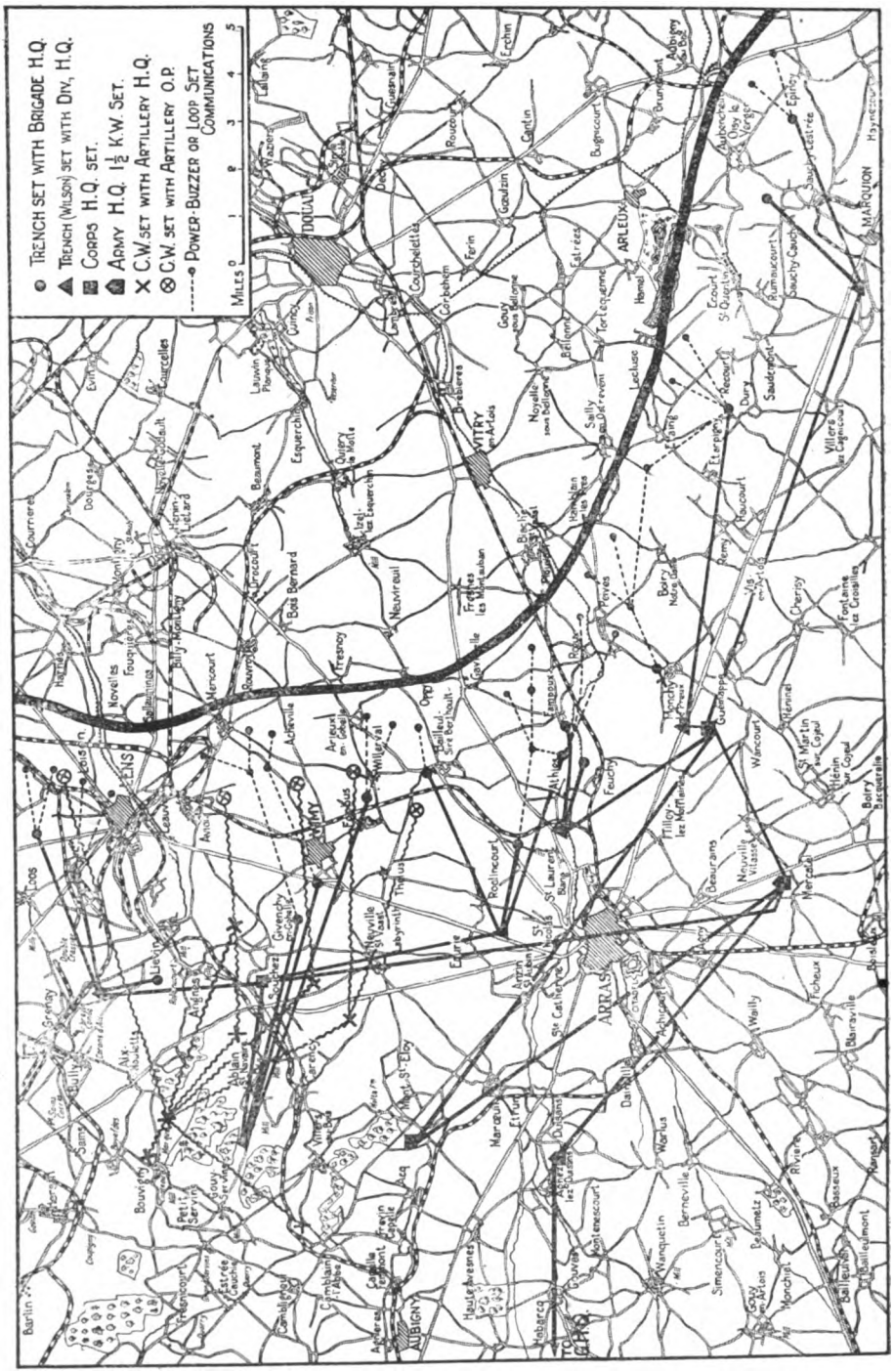

The First Army Front after the British Offensive in August, 1918, had started.

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tillery brigade used practically nothing but C.W. sets for its communications to O.P.'s and batteries for at least three weeks on end, giving up laying telephone line altogether. It was still using C.W. only when last I heard of it.

A striking example of wireless as sole means of communication is afforded by the Canadian Independent Force. A most formidable collection of armoured cars, machine guns and pompoms mounted on cars and lorries, this force would "sail out into the blue" once the fighting became open enough, engaging machine-gun nests and anti-tank guns with great success. One car carried a C.W. set which kept the force in touch with a special set at a convenient headquarters behind our line, sending back reports and keeping the force itself informed of the progress of events elsewhere. That it was possible to keep such a detached force in close touch with the commander of the main body of attacking troops is a remarkable demonstration of the value of wireless in modern warfare.

Similar service was rendered by C.W. sets provided for parties of scouts working as special observers all along the front, and sending back reports by wireless. These reports which were concerned with the progress of our operations, the movements of the enemy, and possible targets for our artillery, were sent and acknowledged without the slightest trouble over distances varying from ten to twenty miles. A collection of the messages sent by only one such station during a day of battle makes interesting reading. From the first message. :—" Our men over (the top) 5 a.m. enemy barrage (come) down 5.05 a.m. our troops reached——and——," onwards through the heat and turmoil of the day's battle, the messages show how perfect and rapid was the wireless communication. The staff frequently expressed their appreciation of the continuous success of these sets.

(To be continued.)

Photo. *Wireless Directing Artillery.* A.I.A.

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Notes of the Month

ROYAL AERONAUTICAL SOCIETY'S GARDEN PARTY.

"DIRECTIONAL wireless, in all probability, will render nautical astronomy as dead as a doornail." Such was the assertion of Commander T. Y. Baker, R.N., of the Compass Department of the Admiralty, in a lecture on "Navigation on a Transatlantic Flight," given appropriately enough in a Hangar at the Handley-Page Aerodrome on the occasion of the Jubilee Garden Party of the Royal Aeronautical Society on June 29th. Commander Baker followed up his interesting pronouncement with a verbal picture of the time when by means of whole chains of directional wireless stations and specially prepared curve charts it will be possible for aerial and marine navigators to plot their positions independent of all adverse conditions.

At the same function there was a most attractive exhibit of modern scientific aids to aerial warfare. This had been prepared by the Technical and Research Department of the Air Ministry and included various types of wireless transmitters and receivers employed by the Royal Air Force for telegraphy and telephony and a direction-finding outfit such as was fitted by the R.A.F. to big bombers of the Handley-Page type.

WIRELESS EQUIPMENT OF THE N.C.4.

The official description of the American Naval seaplanes which figured in the recent Transatlantic flight, contains the following interesting details: "Complete wireless installation, including telegraph and telephone and wireless direction indicator, is provided. System should give a radius of about 300 miles (480 km.) while in the air and of 100 to 150 miles while on the water.

"Electric energy is furnished by an electric generator operated by a wind-driven propeller. Energy is delivered to storage batteries. In addition to operating wireless set the storage batteries operate a complete lighting system for interior of the boat and for wing-tip, and tail lights as well as lights for night landing.

"The wireless operator and engineer are stationed in the main after-compartment just aft of the gasoline tanks. Each is provided with a complete instrument board. Each of these operators has a cylindrical upholstered stool with back rest weighing 5 lb. (2.2.kg.) complete, in the interior of which can be stored the small hand tools required for emergency work."

CANADIAN D. F. STATIONS.

During the war the Canadian Naval authorities erected four stations equipped with direction-finding apparatus for the purpose of locating enemy vessels and aiding allied or neutral shipping. The stations, which are constructed on the Bellini-Tosi principle, are situated at Cape Sable, Nova Scotia; Shebucto Head, Halifax Harbour; Cape Canso, and Cape Race, Newfoundland. They are now being operated for the benefit of shipping in general.

WIRELESS CLUB NOTES.

Three Towns Wireless Club.

June 19th was devoted to instructional purposes, the Chairman being Mr.

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Jerritt, who congratulated the members on the splendid progress they were making. He also informed the members that he had that day received from the Postal authorities his 10-inch induction coil, which was a good sign for amateurs, as it showed that the hard and fast rule with regard to the use of wireless apparatus was being relaxed.

June 26th.

There were several new members enrolled at this meeting. Mr. J. Jerritt presided. Mr. Voss, one of the members, gave an interesting lecture on Primary and Secondary Batteries. It is hoped as soon as permission can be obtained to construct instruments for the Club and also to apply for a licence and erect an aerial.

The Club will be pleased to welcome visitors and to enrol new members. All communications should be sent to W. Rose, Hon. Sec., 7 Brandreth Road, Compton, Plymouth.

Sheffield and District Wireless Society.

A very enthusiastic meeting was held in the Council Room of the Literary and Philosophical Society on June 20th, when a permanently organised Wireless Society for Sheffield and the surrounding district was formed. H. E. Yerbury, Esq., M.I.C.E., M.I.E.E., who presided over the meeting, was elected as President for the ensuing year. It is proposed to secure premises in the centre of the City, if possible, where members may meet to read and discuss papers, and where, eventually, it is hoped, by arrangement with the Postmaster-General, to instal an Aerial and the necessary instruments for experimental work.

The Hon. Secretary is Mr. L. H. Crowther, 156 Meadow Head, Norton Woodseats, to whom application for membership should be sent.

The North Middlesex Wireless Club.

A meeting of the Club was held on June 3rd at Shaftesbury Hall, Bowes Park, and was well attended.

The Chairman expressed his pleasure at being able to see the Club back in its old premises and after a few appropriate remarks, called on Lieut. Holton to continue his lecture on valve-receivers. Lieut. Holton then took up his subject at the point where he had left off at the previous meeting and explained by means of diagrams a number of ways in which these wonderful instruments could be used.

At the close of the meeting a vote of thanks was proposed and duly carried.

Another meeting of the Club was held on June 17th, at Shaftesbury Hall, Bowes Park, the chief feature of the evening being Mr. A. G. Elam's description of a method of Wireless Telephony, ilustrated by diagrams, and a very simple and amusing analogy explaining the action of valve detectors. Mr. Elam has promised to continue his paper on the "Arc" method of wireless speech at a future meeting of the Club.

A vote of thanks was proposed to Mr. Elam at the close of his lecture, and was duly carried.

Full particulars of the Club may be had from the Hon. Secretary, Mr. E. M. Savage, "Nithsdale," Eversley Park Road, Winchmore Hill, N.

EXHIBITION OF WIRELESS TELEGRAPH APPARATUS.

Those attending the British Scientific Products Exhibition at the Central Hall, Westminster, between July 3rd and August 5th, will have the opportunity of inspecting a very fine selection of wireless apparatus which is being displayed by Marconi's Wireless Telegraph Co., Ltd. This includes the Marconi Low Power Telegraph sets for Aircraft direction - finding apparatus,

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short-range wireless telephone sets (special 20 watt sets working with frame aerials inside the building) and the Marconi ¼ k.w. Cabinet set.

Similar apparatus will also be on view at the Shipbuilding, Engineering and Machinery Exhibition at Olympia (September 25th to October 17th), and in addition there will be shown the various standard ship sets.

The same Company is exhibiting at the Federation of British Industries Exhibition at Athens (October 13th to November 14th).

NEW WIRELESS STATIONS.

The coast station at Nieuport has been closed.

New stations have been established at Ostend and Antwerp.

Pending the re-establishment of normal services, these Stations are only open for communications exchanged

(1) Between the Owners and Masters of ships. Such telegrams must be written in plain language and refer to the route or the safety of the vessels.

(2) Between Masters and Naval Authorities. Communications concerning mines may be sent in code or plain language.

MARCONI'S WIRELESS TELEGRAPH CO. v. THE POSTMASTER-GENERAL.

The hearing, before Mr. Justice A. T. Lawrence, of the arbitration between Marconi's Wireless Telegraph Company and the Postmaster-General, to assess the damages due to the Company for the repudiation by the P.M.G. of the contract between the Company and the Government for the erection of six wireless stations in the Imperial wireless chain, is still continuing as we go to press.

THE BRITISH SCIENTIFIC PRODUCTS EXHIBITION.

The above exhibition was formally opened on July 3rd, 1919, by the Most Hon. the Marquess of Crewe, K.G. (President of the Exhibition), assisted by Lord Moulton, K.C.B., and the other members of the Organising Committee. The Chairman (Lord Sydenham) and the other speakers referred to the very great importance of Scientific Research and of the value of the British Science Guild (and of these exhibitions in particular), as an intermediate link between the academical side of scientific research, and the practical and industrial application of such researches by the manufacturers of the country. Sir Richard Gregory (Chairman of the Exhibition Organising Committee) pointed out that no one could say in what direction a given piece of scientific research or discovery would lead or would find practical application, any more than one could foretell the subsequent career of a young child. As an example he instanced the important developments of wireless telegraphy and telephony from apparently unproductive laboratory investigations. The use of the valve for wireless telephony was an excellent illustration of the application of an obscure physical phenomenon (the unilateral conductivity of the vacuous space in an electric lamp) to an important commercial field.

GOLD MEDAL FOR RADIO WORK.

On May 7th at a meeting of the Institute of Radio Engineers in New York, Mr. E. F. W. Alexanderson was presented with the Institute's Gold Medal in recognition of his original research and inventions in the field of radio-telegraphy. Mr. Alexanderson is well known to most of our readers as the inventor of a high-frequency alternator which is capable of generating several kilowatts of H.F. energy at 200,000 cycles. He has also invented a very important magnetic amplifier

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The Weagant "X-Stopper."

(Continued from July Number.)

AS mentioned in the previous part of this description (July Number, p. 211) it has been found as the result of the extended experiments with this apparatus, that whereas the "grinder" type of atmospheric appears to be propagated in a vertical direction, perpendicular to the earth's surface, the "clicks" arrive at the receiving station from various horizontal directions. It is therefore not possible to cancel out the X's of this latter type by the arrangements that have already been described. The " grinders " are found to be the most troublesome form of X's in transatlantic reception during the warm days and the "clicks," which sound like relatively widely spaced crashes in the telephones, are most noticeable during the cooler periods of the day and year. They do not, however, except on rare occasions, reach an intensity sufficient to interfere with the reception of signals, the strength of which is equal to the normal strength of Carnarvon or Nauen. With weak signals, however, the intensity of this type of atmospheric is sufficient at times to cause great difficulty in reception.

If a single receiving loop is employed as in Fig 3 (June issue) it will pick up, if properly tuned, atmospherics of both the above-mentioned types.

In order then to cancel out *all* the atmospherics from the detector circuit it is necessary to have a source of atmospherics of the *same frequency and decrement* as those occurring in this loop circuit. This auxiliary source of X's must not at the same time introduce into the detector circuit any signal currents (although tuned to the same frequency as the incoming waves) or these would partially or entirely cancel out the signal currents originating in the main receiving loop. This desired source of X's may be secured by making use of the principle employed in the two-loop arrangements already discussed, by reversing the connections to one of the loops so that instead of cancelling out the X's and leaving the signals, we cancel out the signal currents and leave the X's. The source of atmospherics thus obtained is then connected in opposition to the signal and X currents, as shown in Fig. 9. In this diagram A and B are the two outer loops connected through the tuning circuits L_1L_2 $C_3C_4L_8$; and L_3L_4 $C_7C_8C_9$ in a similar manner to the previously described arrangement, Fig. 4. The coils L_8L_9 form the fixed coils of the goniometer coupling between the two outer loops. The third goniometer coil is shown split into two parts L_{10} L_{10}' coupled to L_8 and L_9. This coil forms an intermediate circuit coupled inductively through L_{11} L_{12} to the detecting (or amplifying) valve as indicated.

The main reception takes place on the central loop E which is coupled to the same intermediate circuit through coils L_5 and L_7, while the atmospheric disturbances are cancelled out in this circuit by proper adjustments of the sense of the couplings $L_8L_9L_{10}$.

This arrangement was found to result in a material improvement in working over that obtained with the two-loop circuits.

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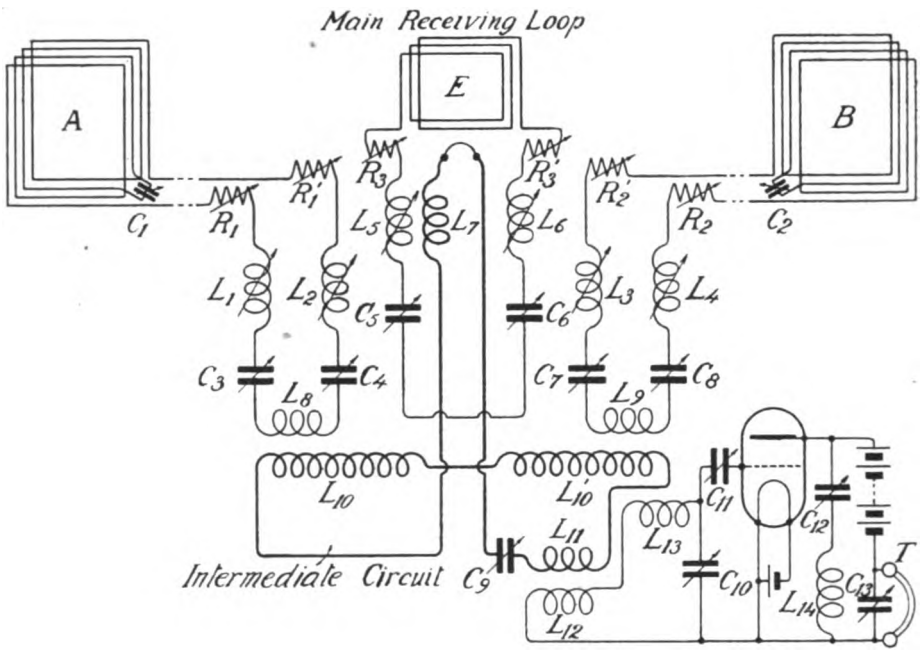

Fig. 9.

A modified form of this three-aerial arrangement is indicated in Fig. 10. The main point of difference lies in the substitution of two low horizontal wires for the third receiving loop. The signal is received on this aerial which is coupled to the goniometer intermediate circuit exactly as in Fig. 9. The outer loops pick up the static and signal, but are arranged to cancel out the signal between themselves by the goniometer $L_1L_2L_3$.

It should be noted that in the arrangement shown the two localised loops connected to the station by long horizontal leads have been replaced by two extended loops stretching out from the station itself.

This was found a more satisfactory arrangement as it dispensed with certain disturbing effects sometimes experienced when the leads were used. It was further found essential to insert inductances L_9L_{10} in the *upper* wire of these loops as otherwise the tuning of the loops could not be varied at the station end so as to enable reception of various wavelengths. The best position for these coils is near the centre of the upper wire. Their effect was much less if inserted in the lower wire.

Many arrangements have been experimented with at various stations of the American Marconi Co., in order to gain the advantage of this three-aerial arrangement in a limited space. Very successful results have been secured with a combination of a receiving loop and a double "horizontal wire" aerial only 30 feet long, provided that arrangements are made for rotating the "horizontal wire" aerials in any direction in

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the horizontal and vertical planes, so that the signal can be cancelled out and the static left in their circuit as was done in the case of the two outer loops of the large arrangement. A multi-valve amplifier is of course essential with such small aerials in order to receive over long distances.

As to the results obtainable we may quote a typical example from Mr. Weagant's paper read before the Institute of Radio Engineers in which these arrangements were described: "Many attempts had been made during the summer to copy these stations [Eiffel Tower and Lyons on 8,000 metres giving weak signals] with the two-aerial arrangement, but the results were satisfactory only occasionally and when the grinder type of static was that which existed. When the other type [clicks] was present these stations could not be read. During the test with the three-aerial arrangement on one ocasion, in the evening, static of extreme intensity was experienced, and the intensity of the signal from Eiffel Tower was much below normal ["fading effect"], with the result that with the two-aerial arrangement it was barely possible to tell that the signal was present. Using the three-aerial arrangement the signal was not only readable but of such intensity that it could be read with the telephones a couple of feet from the ear. Continued use has established beyond question that this performance is not occasional or accidental, but consistent, and that with this arrangement transatlantic radiotelegraphy can now be carried on free from interruptions due to static of any kind whatever except local lightning."

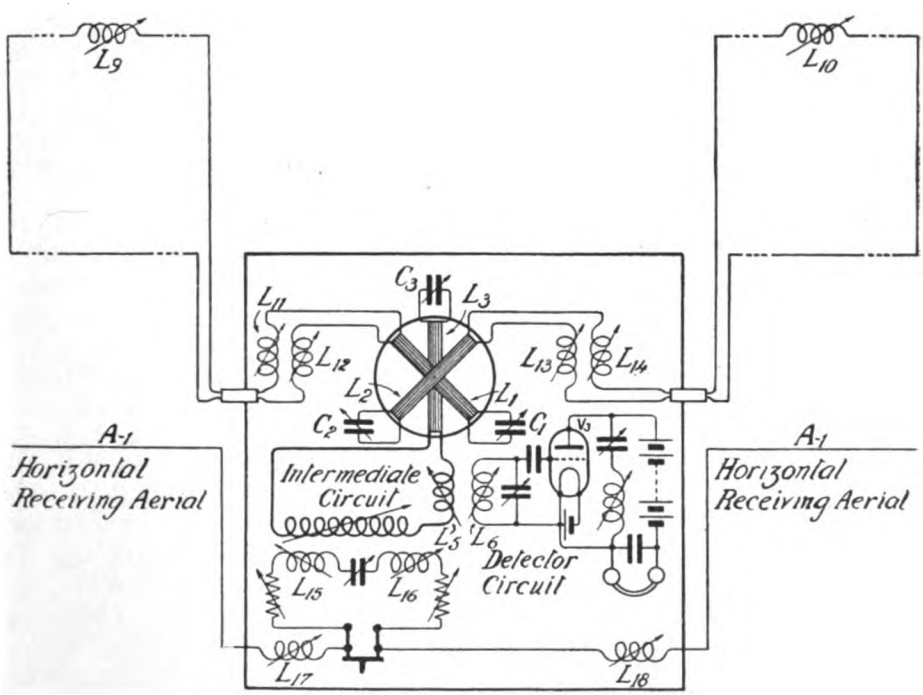

Fig. 10.

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The Damping of Wireless Telegraph Signals

Some Special Investigations in the West Indies.

By G. H. Wood, A.M.I.E.E.

THE following was written at a time when the author was in charge of the Trinidad-Tobago W/T. Service. Owing to the breakdown of cable communication between British Guiana and Trinidad for a considerable period all the telegraph traffic between British Guiana and the outside world had to be dealt with by the Trinidad Wireless Service. Although the Trinidad W/T. Station at Port-of-Spain should have been in easy range of the W/T. Station at Georgetown it had been found quite impossible to work direct by daylight, and all traffic had to be relayed by Tobago. This led to a great waste of time and to very uneconomical working, and was generally unsatisfactory. The author therefore conducted a research to endeavour to discover the cause of the extraordinary damping of W/T. signals between Port-of-Spain and Georgetown, the results of which are embodied in this article.

In connection with the matter of the extraordinary damping of W/T. signals between the Port-of-Spain Station and Demerara Station we may note the following facts:—

The power of the Port-of-Spain Station is 5 k.w.

The power of the San Fernando Station was 3 k.w.

The power of the Tobago Station is 3 k.w.

The power used by the Georgetown Station for the purpose of this report is unknown, probably 5 k.w., but at all events sufficient power was used to ensure good daylight communication under ordinary conditions.

All three of these stations are under ordinary conditions within easy daylight range of the Georgetown W/T. Station.

We now come to the "damping effect" in question. We know that the San Fernando Station, when it was working, i.e., some years ago, was easily able to exchange traffic with the Georgetown Station, but that the Port-of-Spain Station is quite unable to exchange traffic with Georgetown during daylight, although traffic can be exchanged at night when atmospheric conditions are favourable.

During daylight hours, the whole of the Port-of-Spain-Georgetown traffic has to be relayed by the Tobago Station, a station of smaller power, lower aerials, and no nearer to the Georgetown Station. From this fact and from the fact that the power available, etc., should be ample to ensure good communication (as it does to other places at greater distances in other directions) we gather that there is some extraordinary damping effect existing between Port-of-Spain and Georgetown which absorbs and damps the transmitted waves. As the damping effect is quite

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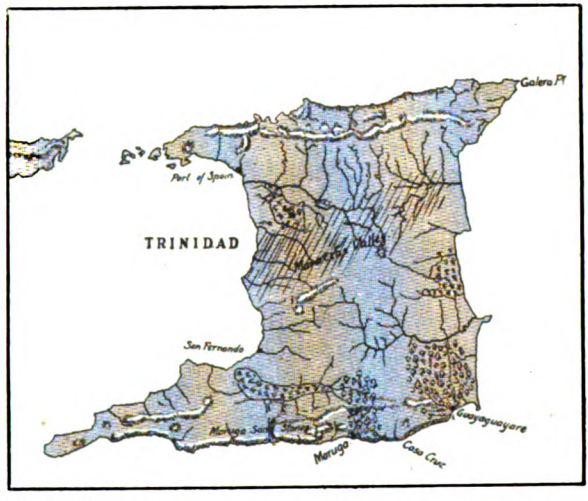
regular and shows practically no variation we can safely assume that the damping is not caused by any unusual conditions in the æther. A theory as to this effect is now given showing that this damping effect to be made up of two quite separate components.

Referring to the accompanying map of Trinidad :—

(a) The Southern Hills contain up to 20 per cent. of iron ore.

(b) The Northern Hills contain "stringers of magnetite" 18 inches thick.

(c) The Maracas Valley contains 67 per cent. of iron ore.



Map of Trinidad, showing iron ore deposits and sandstone region.

(d) It is also known that North of San Fernando and running in a North-easterly direction there is a band of iron ore stretching practically across the Island and averaging 8 miles in breadth.

(e) In the South of the Island the deposits known as the Moruga sandstones occur; these vary in breadth up to a maximum of about 20 miles (approx.) and contain a considerable percentage of iron ore.

Experiments were carried out with a ship steering round the South and East coasts of Trindidad with the following results :—

In Moruga (South coast) signals from Port-of-Spain were very good. Signals were lost altogether at Casa Cruz, and were very weak at Guayaguayare. Signals strengthened slightly from Guayaguayare up the East Coast, but were completely lost so soon as the hills of the Northern Range intervened, and were not heard again until the ship was two or three miles North of Galera Point.

For the particular purpose of this investigation we must note particularly that at Moruga the signals from Port-of-Spain were very good, whilst at Guayaguayare signals were very weak.

It is known that in connection with wireless telegraph stations in Northern South America that the dense tropical forests exercise a large damping effect on wireless waves.

Let us study the question as to why W/T. signals from the Port-of-Spain Station should be "very good" at Moruga and "very weak" at Guayaguayare. On referring to a map of Trinidad which shows the areas of land under cultivation, we find that a straight

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line from Moruga to Port-of-Spain gives the smallest area of forest to be passed over by the æther waves. On the other hand, a straight line from Guayaguayare to Port-of-Spain passes over a maximum of forest; i.e., waves transmitted to Guayaguayare will have at least twice the amount of forest to pass over than waves sent to Moruga. (It is regretted that in the absence of the map referred to the exact distances cannot be given.) Also, a straight line from Port-of-Spain to Moruga passes over about nine miles of the Moruga Sandstones; whilst a straight line from Port-of-Spain to Guayaguayare passes over about eighteen miles of the Moruga Sandstones.

Thus we see that waves from Port-of-Spain to Moruga will have a minimum of forest and of Moruga Sandstones to pass over, whilst waves to Guayaguayare will have a maximum of both forest and Moruga Sandstones to pass over.

We can therefore readily understand the difference in the damping between Port-of-Spain and these two places.

We now come to the second part of the question. We know that whereas a 3-k.w. Station at San Fernando was able to work the Demerara Station during daylight hours, the 5-k.w. Station at Port-of-Spain is quite unable to work Demerara during daylight hours, although it is able to work greater distances in other directions. Experiments were carried out by a ship steaming round the South and East coasts of Trinidad. It was found that signals from Demerara were very weak all along the South and East coasts of Trinidad, but were strong from Galera Point northwards.

(Note: The receiving apparatus of the ship in question was somewhat insensitive, the aerials being small and low; a carborundum detector, however, was used.)

It would appear therefore that some damping effect exists between the whole of the South and East coasts of Trinidad, and which effect disappears at Galera Point (the most north-easterly point of Trinidad). This damping effect would naturally effect both the San Fernando and Port-of-Spain stations.

A theory has been advanced that this damping may be due to a dephasing effect of the Demerara Coast line, i.e., waves from Port-of-Spain on striking the Demerara coast line and travelling along a portion of it are put so much out of phase that by the time they arrive at Georgetown Station they partially neutralise one another. I have no opinion to give on this theory, but suggest that the damping effect in question may be purely due to absorption; certainly part of it would be. Waves from Port-of-Spain to Georgetown have 95 miles of land to travel over at the Demerara end. It should be particularly noted that at Galera Point (where signals from Georgetown are well received) the waves would miss the coast line and travel only over the sea; thus we may assume that the damping due to the land is purely absorption, or the dephasing effect mentioned or both.

If we take a straight line from Port-of-Spain to Georgetown we note that it passes through Guayaguayare and over the land of Demerara for a distance of 95 miles (approx), and a line from San Fernando to Georgetown passes through Moruga and also over the land to Demerara for a distance of 95 miles (approx.). We also know that a line from Port-of-Spain to Georgetown will pass over the band of rock containing a high percentage of iron ore situated to the north of San Fernando. A line from San Fernando to Georgetown does not pass over this band.

We are now able to say that the damping between Port-of-Spain and Georgetown is composed of two components:—

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A. That in the island of Trinidad itself being
   1. Absorption due to forest.
   2. Absorption due to iron in rock, i.e.,
      a. The band running N.E. from San Fernando.
      b. The Moruga Sandstones. 18 miles broad.

B. That due to the Demerara coast being
   1. Absorption of Soil. (N.B., the nature of this soil should be ascertained.)
   2. Dephasing effect of coast line if any.

This total damping is sufficient to prevent daylight communication.

The damping between San Fernando and Georgetown is composed of:—

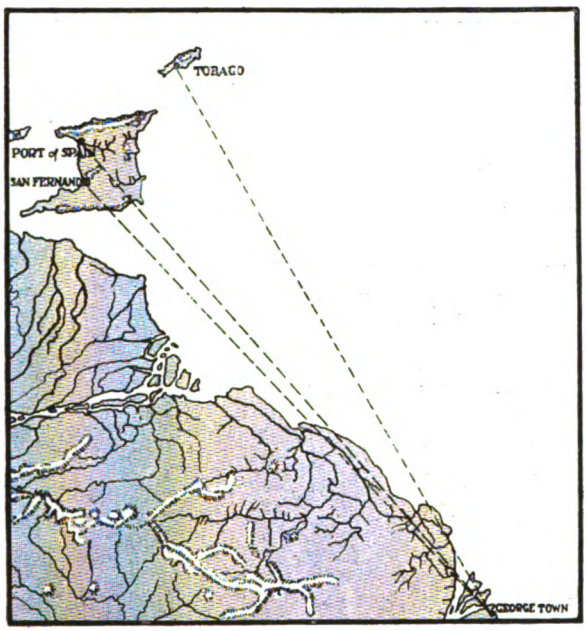
A. That in the island of Trinidad itself being
   1. Absorption due to forest, which is much smaller than in the case of Port-of-Spain.
   2. Absorption due to iron in rock, i.e., Moruga Sandstones, 9 miles broad.

It will be noted that there is about 17 miles less of iron in rock between San Fernando and Georgetown than between Port-of-Spain and Georgetown.

B. That due to the Demerara Coast being the same as in the case of Port-of-Spain.

The total damping in this case was of such an order that daylight communications could be held with Demerara.

The damping between Tobago and Georgetown being due to absorption by sea only is much less than in the two former cases, and is of an order to enable easy daylight communication to be maintained.



Map showing relative positions of stations referred to in article.

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Aircraft Wireless Section

Edited by J. J. Honan (late Lieutenant and Instructor, R.A.F.).

These articles are intended primarily to offer, as simply as possible, some useful information to those to whom wireless sets are but auxiliary "gadgets" in a wider sphere of activity. It is hoped, however, that they may also prove of interest to the wireless worker generally, as illustrating types of instruments that have been specially evolved to meet the specific needs of the Aviator.

AIRCRAFT WIRELESS SETS.

THE NO. 1 TRANSMITTER—(Continued).

Fittings and Accessories.

HOT-WIRE AMMETER.

THE oscillating aerial current is measured by means of its heating effect upon a conducting wire, having a high coefficient of expansion.

In the ordinary type of instrument, Shown in Fig. 11, the current-carrying wire is stretched between two points, and is connected at its centre point to a fibre which passes around the axle of a drum carrying the indicating-needle. The other end of the fibre is tensioned by an anchoring-spring.

As the conducting wire is heated by the current it expands, and the slack is taken up by the tensioned fibre, the consequent movement of which rotates the drum, and the indicating-needle supported thereon.

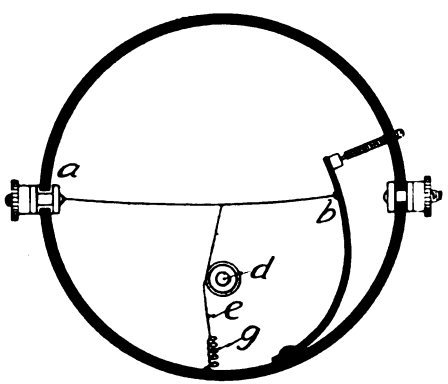

Fig. 11.

The disadvantages of this type of ammeter are (a) that the fibre is apt to slip to some extent around the drum axle without rotating it, and (b) that in resetting the needle to zero any alteration of the initial tensioning of the conductor tends to throw the calibration of the indicating scale out of the true.

Should the ammeter break down when in use, and so open the earth circuit, the instrument should be short-circuited by joining the terminals with a piece of wire.

In the Ewen ammeter the indicating-needle is carried on a collet mounted on a jewelled spindle set at right angles to the conducting wire. On the same spindle is mounted a hair-spring which exerts a twist between two fibres suspended between it and two points on the conducting wire. The torque on the bifilar members and the tension of the conductor are initially adjusted by the makers, so that the needle points to zero, and this adjustment is then sealed up.

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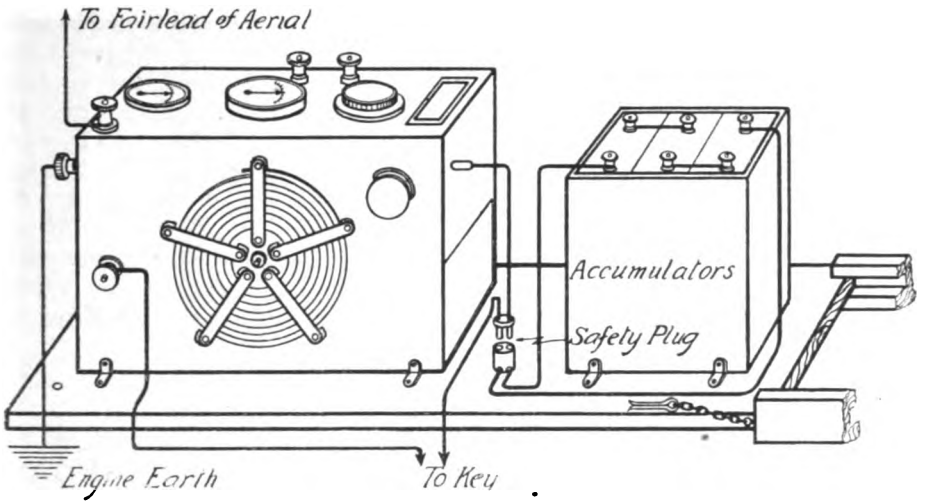

Fig. 12.

As the conductor expands under the action of the current, the sag affects the equilibrium of the bifilar suspension, and thereby allows the hair-spring to rotate the spindle and the indicating-needle.

In resetting the needle to zero, the whole unit, comprising the spindle, hair-spring, and needle, is rotated upon a central pivot by means of an external lever, leaving the calibrated scale still true to reading.

FITTING THE No. 1 SET.

As, apart from the spark-gap, break contacts, and the helix clips, there are no parts on the transmitter likely to give rise to trouble from vibration effects, it is not necessary to use spring suspension devices or shock absorber, in fitting the set into the bus. As an extra precaution, an elastic cord suspension, similar to that used in slinging valve sets is sometimes employed; or the transmitter may be fitted with "artificial sponge" buffer at the base.

In practice, however, provided that the locking nuts on the adjustable parts have been duly tightened up, it is sufficient to clamp both the transmitter and the battery directly on to a baseboard by means of a couple of metal lugs and a screw turnbutton, as shown in Fig. 12, and then to slide the whole piece into a wooden retaining-frame screwed down in a convenient place in the nacelle, preferably behind or under the pilot or passengers' seat.

An improved form of helix clip is shown in Fig. 13. This has a locking-nut, which, when the contact has been adjusted, can be screwed down on to the metal ribbon, and prevent any possible displacement from vibration.

The three accumulators are fitted into a wooden box built to house them snugly, and this is also clamped to the baseboard with the set.

Obviously, however, the particular arrangement and placing of the set and battery is simply a mater of expediency and accommodation. They can be stored wherever they will fit, provided that the transmitter is reasonably accessible in case any adjustments are necessary in the air as regards wavelength—or possible minor faults. It is also wise

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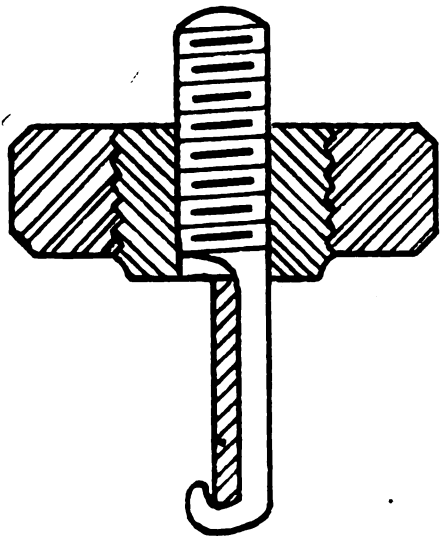

Fig. 13.

not to place the transmitter where it may be subjected to contumelious treatment, deliberate or otherwise, from the pilot's or observer's feet. Old habits die hard in some people, and there are still pilots who will debit any little untoward bump, or sudden change in the weather conditions aloft, to the account of the unfortunate wireless gear, in which case excessive radiation may take place and a new set be required.

THE SAFETY PLUG.

This is generally employed in the wiring arrangement. It is not considered healthy to have leads, capable of emitting sparks if short-circuited, kept "live" for a longer period than is absolutely necessary in an atmosphere that may be highly charged with petrol vapour. The practice is based upon a tradition that a blaze, following a crash, was once upon a time officially attributed to this cause.

The leads from the battery are therefore taken to a socket, and the circuit containing the transmitter and key ends in a plug which is inserted into the socket only when the set is required for action. When the set is temporarily out of use the plug is withdrawn and the circuit outside the battery is then dead. The wiring arrangement, including the plug, is shown in Fig. 13A. The safety plug may be placed in any convenient site. Somewhere near the key, preferably, in order to avoid if possible any natural irritation that may arise from conscientious but futile attempts to radiate signals without the aid of the battery.

THE KEYS.

Care should be taken to fix the key in a position, and at a height, that gives the operator the minimum trouble in sending. The tension and adjustment screws should always be tested prior to flight. These are small points, and obvious, but it pays to attend to them.

KEY SIGNAL LAMPS.

Where two or more keys are to be fitted it is desirable to introduce an auxiliary circuit, which when any one

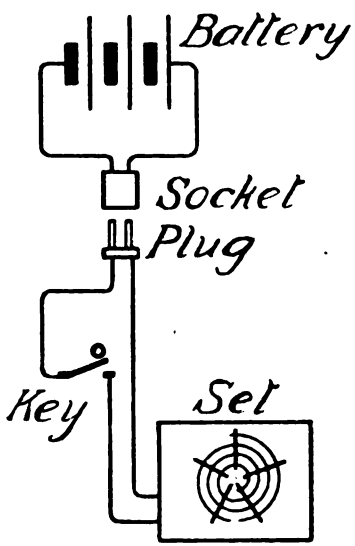

Fig. 13A.

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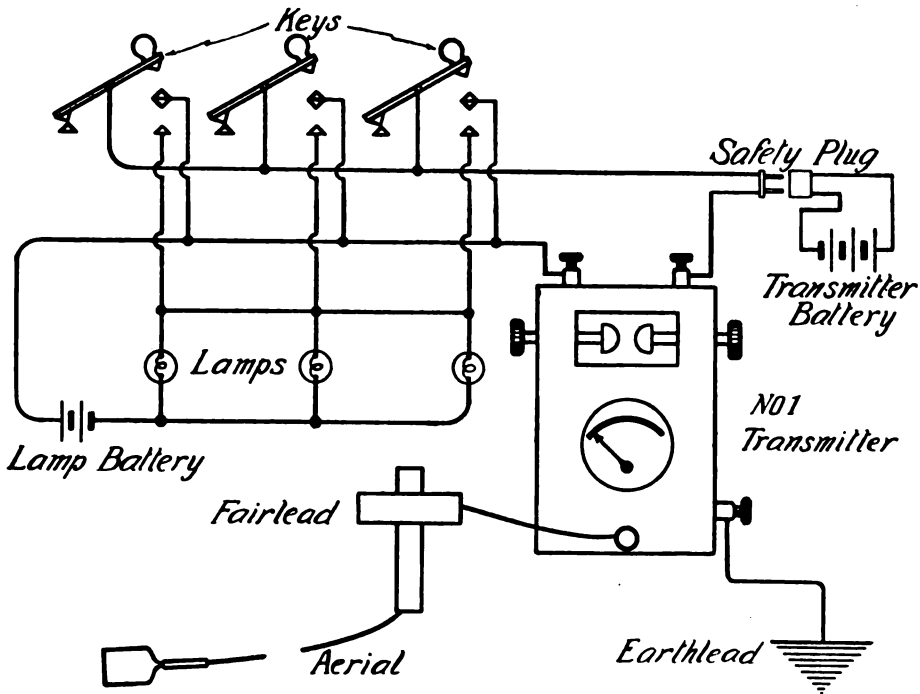
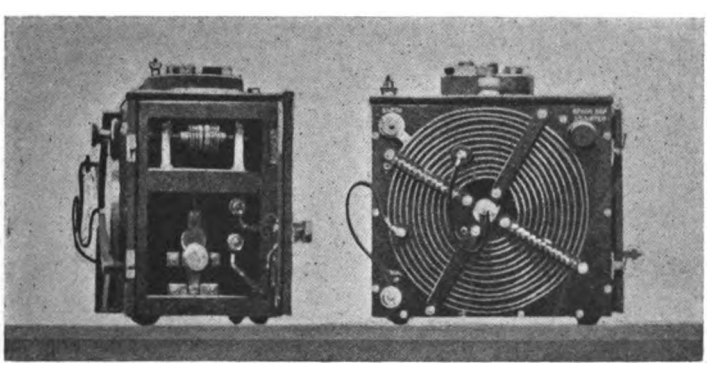


Fig. 14.

key is being used, lights up a small signal lamp mounted on the base of each key, so as to avoid simultaneous signalling by warning other operators that the set is in use.

A simple wiring arrangement for this purpose is shown in Fig. 14 as applied to a set comprising three keys and three signal lamps. One additional dry cell or accumulator is sufficient for the three lamps. The contacts require careful adjustment to ensure that, whilst they do not "short" in the idle position, the ordinary pressure exercised in operating the sending key is sufficient to close both the set and the lamp circuits.



The No. 1 Transmitter.

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Aviation Notes.

THE TRANSATLANTIC AIR ROUTE.

UNFORTUNATELY, like most monthly periodicals, we are compelled to go to press so far in advance of the date of publication that it is impossible to keep hot on the track of late events. Otherwise it would have been possible to record the first real non-stop cross-Atlantic flip in our last number.

It is perhaps old news by now, but it will be long before it grows stale. Hawker's dash provided plenty of thrill, but lacked success; whilst the American achievement somehow failed to stir the blood to fever heat—though their record will always stand good.

It was left to Alcock and Browne—the two new Knights of the Air—to crown the dash and pluck that flavoured the Sopwith flight with the laurels of success.

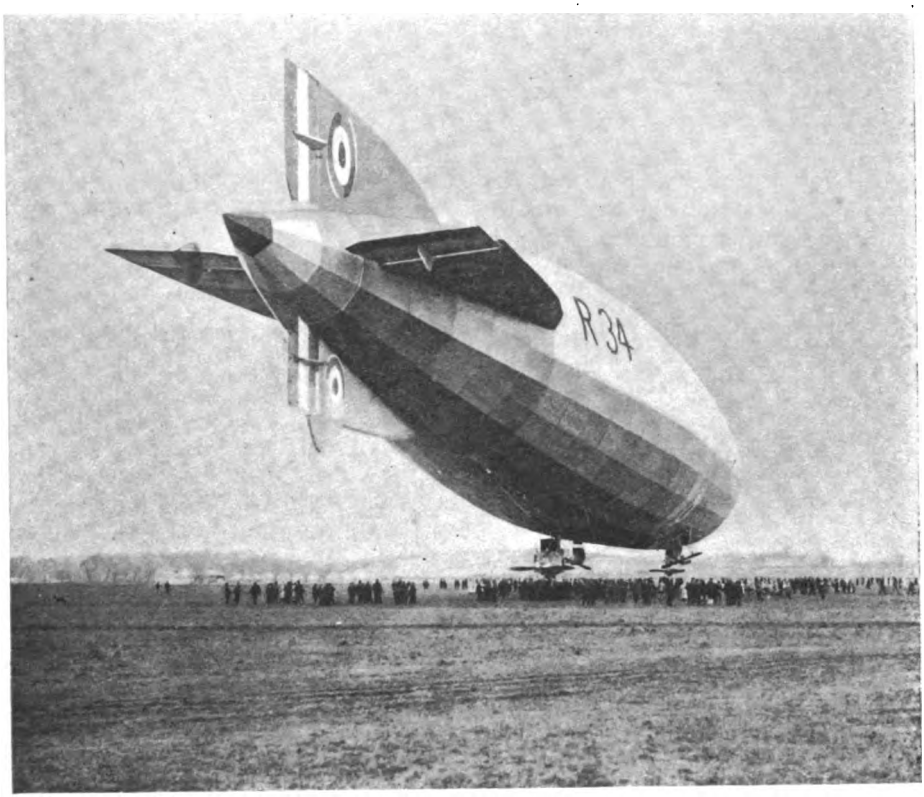

Photo: *The R34.* Topical Press.

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Photo: *The Officers of the R34.* Topical Press

Back row, left to right: Capt. Coombes, Lt.-Com. Lansdowne (U.S.A.), Lt. Durrant (Wireless), Capt. Greenhard (1st Officer), Major Pritchard, Lt. Shotter (Eng. Officer).
Front row, left to right: Major Cooke (Navigator), Col. Hunt (C.O. of East Fortune). Major Scott (Comm. of R34).

Regarding Wireless.

It is most unfortunate from the "wireless" point of view that the sets carried by both the British buses should have gone wrong from the start.

In both instances service instruments of proved utility were carried, and the only inference to be drawn is that the poor "wireless gadgets" were afforded somewhat haphazard attention.

Under the exceptional circumstances that surrounded the setting-out on a voyage of so uncertain and perilous a nature, it is easy to understand that both pilot and navigator had more pressing concerns than the well-being of the W/T. sets, and that these only came in for such care as could be spared to a "side show."

"Some" Organisation.

It is only right, however, to point out that this apparently insignificant defect practically rendered futile, so far as these two buses were concerned, quite an extraordinary amount of spadework that had been quietly but thoroughly carried out in wireless quarters with a view to rendering every possible assistance to the ventures, both prior to the start and whilst in passage.

This organization did not seek for publicity, and has been given but little notice in the press, though the various

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parties concerned have received a full and warm appreciation of their efforts from various British and American official sources.

Perhaps it will not be out of place to detail some of the arrangements that were made, and that actually proved of great service, more particularly in the case of the NC4, which with characteristic Yankee thoroughness, succeeded in maintaining its W/T gear in an efficient condition throughout the passage.

The organization in question comprised the British Admiralty and the Royal Air Force; the American Naval Service; the various Steamship Companies whose vessels ply the North Atlantic; and last, but by no means least, the Marconi Company, which rendered such assistance as could only be secured by the exceptional wireless service that it controls and by the willing co-operation of its widespread staff.

Details.

The captains of all North Atlantic vessels rendered most valuable assistance in furnishing exhaustive weather reports which were promptly transmitted to various coast stations and forwarded to official headquarters for compilation and record.

Special facilities were given by the Admiralty for the transmission of these messages from such vessels as were out of range of Valentia. In addition, the Marconi Company made special arrangements for reception at their Ballybunion Station. Three experienced operators were detailed by them to that station solely for work in connection with the receiving of meteorological reports relayed from ships at sea.

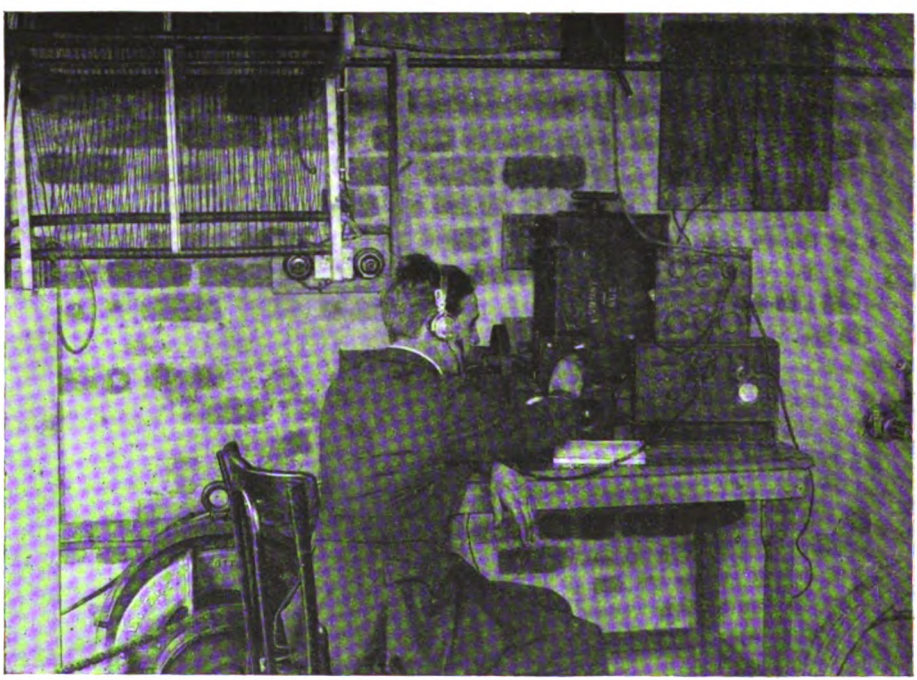

Photo: *The Wireless Station at East Fortune.* Topical Press.

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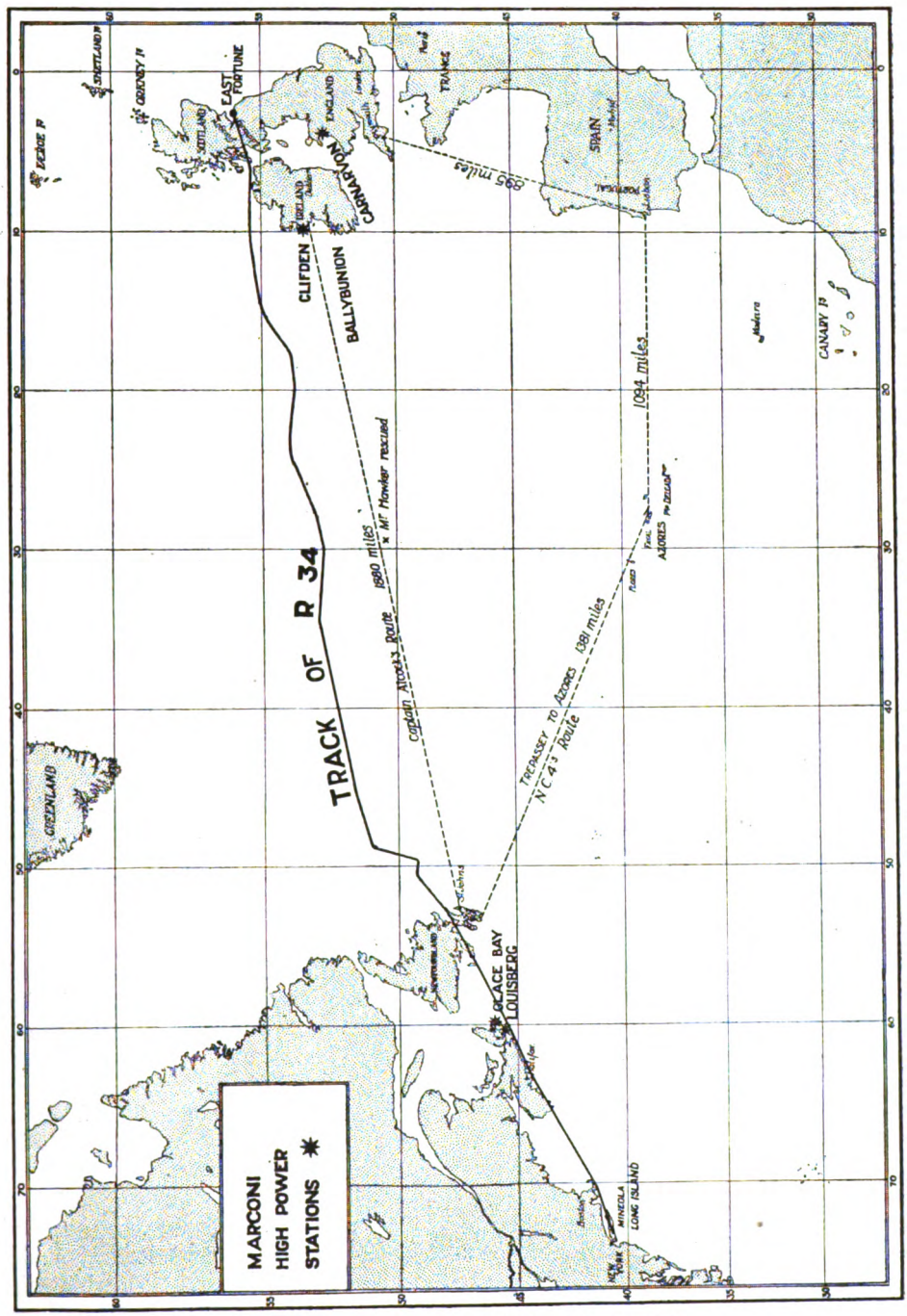

The routes of the three successful Transatlantic flights.

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Continuous land-line communication was maintained from Ballybunion Station so that all such messages could be forwarded to London without delay, where a special day and night staff was maintained at the Air Ministry to deal with them.

Arrangements were made with the Canadian Marconi Company for the Cape Race Station to be advised immediately any plane made a start, and to inform all ships accordingly; and, further, to distribute all weather reports issued by the Air Ministry for their guidance *en route*.

The Carnarvon Station was entrusted with the transmission of meteorological reports at specified times.

All ships' operators were instructed as to the calls allotted to the various planes that were in readiness to start, and were also asked to co-operate with the aviators in respect of requests as to their position, S.O.S. calls, etc.

A special chart was periodically prepared by the Marconi people showing in detail for the Aviator's guidance before setting out, the number and approximate position of all ships carrying wireless that would probably be met with or overtaken during the flight.

These are but some of the steps taken to ensure a thorough co-ordination of land and sea wireless facilities in the service of Aviation, but sufficient has been said to indicate the work that was done, and the credit that is due, even if it has not been rendered by the public generally, to those who, standing quietly in the background, have done such painstaking and useful work.

The day will doubtless come, sooner or later, when we shall have a regular Transatlantic Aircraft Service in existence, able to wing a serene course straight from port to port. Air Navigation will by then have ceased to be a doubtful quantity vaguely dependent upon a chance "sight" of the celestial bodies, and happy in the achievement of a lucky trip across the pond.

When this time arrives the wireless man will have been found worth his salt, whether for actual work in the air, or for services in meteorological spade-work.

Meanwhile there is no reason why his present work should be ignored.

THE R34.

As this is being written, news has been received of the safe arrival of the R34 at Mineola, Long Island, after an uninterrupted flight of 3,500 miles at an average speed of 33 miles per hour.

The Air Service has *not* neglected its wireless gadgets, and the vessel has been kept in continuous touch with the world throughout her voyage.

In a trial flight, previous to setting out on her transatlantic trip, she succeeded in setting up direct communication in the air by wireless between the Firth of Forth and the Azores, a distance of roughly 1,500 miles.

Besides a low-power 600 metre spark instrument, she carries a high-power C.W. set which has a range up to 1,500 miles, the latter being an extraordinary achievement for an air-borne transmitter. There is also a wireless telephone outfit giving a range of 50 miles.

In addition, she is fitted with a multi-valve receiving-set of great sensitivity, and a radiogoniometer installation.

The wireless cabinet is carried in the forward or navigating gondola which is in telephonic communication with each of the other three gondolas and with the various crew stations.

The call letters D.M.D. were allotted to the vessel, and the Marconi Station at Clifden sent out signals under this prefix every two hours whilst the ship was *en route*. Arrangements were also made to maintain communication

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with the wireless stations at St. John's, East Fortune, Pembroke, Ponta Delgada, and the Air Ministry.

The following extract is taken from an official statement by the Air Ministry issued prior to the flight:—

"The Marconi Company have kindly placed at the disposal of the Air Ministry their very complete organization of wireless facilities over the North Atlantic, including the free use of their private telegraph lines, and the two high-powered stations at Clifden and Glace Bay. The airship will use these two stations as beacon stations for her wireless direction-finding apparatus."

Wireless and the Cadet Corps.

OUR readers will be interested to learn that instruction in wireless telegraphy is one of the activities increasingly associated with the cadet movement.

The photograph reproduced herewith, taken at the Technical School, Plymouth, shows a class of cadets of the No. II. Plymouth Company, Devon (Fortress), R.E., receiving instruction from Mr. J. Jerritt, Chairman of the Three Towns Wireless Club, and Principal of the Bedford Park Training School of Telegraphy, whose kind offer to assist was readily accepted by the O.C. Cadets, Capt. G. W. Turpitt, B.Sc.

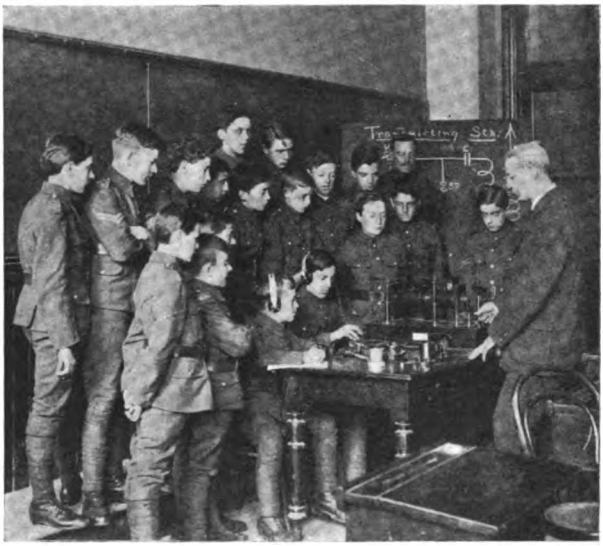

Photo: W. H Hawkings.

The weekly lessons are much appreciated, and the cadets make good progress both in the practical and the theoretical side. The working of land lines is also explained and practice taken with the sounder and buzzer alternately.

Gen. Sir R. I. Scallon, G.C.B., D.S.O., when addressing cadet officers in Plymouth last year, referred to the dearth of really good signallers in the Army, but it is hoped that with the active and patriotic enthusiasm of such expert telegraphists as Mr. Jerritt the cadet companies may supply to the Territorials, year by year, a number of young signallers who will ultimately acquire a high state of efficiency.

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The Library Table

"THE PRINCIPLES OF ELECTRIC WAVE TELEGRAPHY AND TELEPHONY."

By J. A. FLEMING, D.Sc., F.R.S.

London: Longmans, Green & Co.

(Fourth Edition, 1919.) pp. xv+707.

Price 42/- net.

THE publication of the fourth edition of Dr. Fleming's "Principles of Electric Wave Telegraphy and Telephony" affords ample evidence of the lasting popularity and demand for this well-known work. In the third edition which was published in December, 1916, considerable alterations and extensions were made as compared with the original book issued in 1906, in order to bring the volume more up-to-date and to incorporate the results of recent research, discovery and invention in the radio field. The growing bulk of the book has now necessitated an attempt being made to reduce the number of pages without sacrificing the value of the contents. In the new (fourth) edition just issued this has been accomplished by the adoption throughout of a somewhat smaller size of type, and of a more compact style of setting, especially in the mathematical portions. By this means a reduction of over 20 per cent. has been made in the size of the volume without sacrificing the clarity of the reading.

The general scope of this work is too well known to require any very detailed exposition to the general reader. As in the previous editions the author's aim has been to deal throughout as far as possible with the general underlying principles of wireless communication rather than with elaborate and detailed explanations and descriptions of individual apparatus and specialised parts of wireless sets. Many descriptions have however, been given of various apparatus and instruments since such are necessarily essential to a proper exposition of wireless principles.

The historical portions of the book, both in the first chapter on the "Production of High-frequency Currents and Electric Oscillations," and in the chapters on "Detectors of Electric Waves" and the "Apparatus of Electric Wave Telegraphy" have been revised to a considerable extent, and the descriptions of the older and less useful apparatus and instruments have been omitted, although in some cases references to the original paper or descriptions have been retained.

In the theoretical sections dealing with the subject mathematically, the bulk of the matter is necessarily the same as in the previous edition, but some additional information has been incorporated relative to the "High-frequency Resistance of multiple-stranded Insulated Wire," and to the reasons and causes of the increased high frequency resistance that is often experienced with such wires as compared with what is expected from the direct current resistance and the degree of stranding. In the section on the radiation from various forms of oscillator and aerial, some additional notes of recent theories have also been added.

In Chapter VII (The Apparatus of Radiotelegraphy) a slight rearrangement of the matter has been made by the transfer of part of the theoretical dis-

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cussion of direction finding apparatus to a special section, dealing with such gear, that has been added at the end of Chapter VIII on Radiotelegraphic Stations.

The description of the heterodyne receiver remains as in the previous edition, but in this connection it may be mentioned that this receiving arrangement is treated rather more as a specialised form of detector than as a general C.W. receiver for which purpose it is almost universally used. The "range," viz.—3,000 miles,—is also now somewhat in error, as C.W. transmission has been accomplished over much greater distances than this. Any one particular detector or receiver can seldom strictly be said to have any particular "range" as the distance over which signals may be read by its use depends so much upon the other auxiliary apparatus with which it is employed, and upon the power of the transmitting station from which signals are being received.

In conclusion it should be mentioned that some previous existing misprints have now been corrected, but that unfortunately the error in the Table on page 123 has not yet been amended

THE THEORETICAL PRINCIPLES OF WIRELESS TELEGRAPHY.

By I. R.

London: Gee and Co. (4th Edition). 1s. net.

THIS is the kind of treatise for which we are "truly thankful." Our copy came into the office on one of those beautiful snowy days in April which make our English spring what it should not be, and we forgot at once the icicles on the window-frame, the chilly zephyrs which blew along the floor and our miserable attempts to ignite the pieces of slate which some fair unknown had placed in the grate along with the old blotting paper we had discarded the previous day. Every page of this book creates laughter and leaves memories which obtrude themselves upon the mind at moments when one least desires to chuckle. The Chart of Faults on C.W. Sets is alone worth the price of the whole book, and we cannot resist quoting a few reasons which are given to account for specified faults:—(1) Valve dropped from height on stone floor. (2) Shortage of electrons. (3) Gas turned off at meter. (4) Wick used up. (5) Mistake by operator (rare). (6) No signals in the air. (7) Aerial mixed with earth. (8) No phones. (9) Grid grinding against plate.

A new chapter has been added, on the Slide Rule, and needs no further commendation from us than the statement that in our opinion it might have been written by Stephen Leacock in one of his most Leacockian moods. The appendices on the Corkscrew Rule and Waves, the latter taking the form of a letter to "My Dear Children" from "Aunt Mollie," are delightfully funny and well up to the standard of the rest of the matter. We heartily recommend that this book be kept at hand and taken in doses after *mauvais quarts d'heure*.

THE PURCHASE OF BOOKS FOR READERS.

The publishers of THE WIRELESS WORLD are pleased, at all times, to obtain for readers any of the publications reviewed in these columns, as well as books on all technical subjects. Orders should be accompanied by a remittance covering the full cost of the book and postage. Should the amount forwarded exceed that required, the balance will be returned to the sender.

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Personal Notes

MILITARY CROSS FOR RADIO MAN.

MR. J. Scott-Taggart, M. S. Belge E., A.M.I. Radio E., has been awarded the Military Cross for his services in connection with wireless work during the last phases of the fighting in 1918. This gentleman is well-known to our readers as the author of numerous articles on thermionic valves.

DEATH OF LORD RAYLEIGH.

It is with great regret that we have to record the death, at the age of 78, of Lord Rayleigh, O.M., which occurred at his residence at Terling Place, Witham, Essex, on the night of June 30th. The deceased peer was born on November 12th, 1842. He had a brilliant career at Cambridge, graduating as Senior Wrangler in 1865. In the following year he was elected to a Fellowship at Trinity College, a post he vacated in 1871, the year of his marriage to a sister of Mr. Arthur Balfour. He succeeded to the title on the death of his father in 1873 and that year marked his selection as a Fellow of the Royal Society. In 1879 Lord Rayleigh was elected to the Chair of Experimental Physics at Cambridge which was then vacant owing to the death of Clerk Maxwell. As mathematician, physicist, and chemist Lord Rayleigh excelled, but space does not permit us completely to catalogue his achievements in these sciences. He made his reputation by a series of papers on optical questions, wrote a classical treatise on acoustics, discovered Argon, and his work in electricity was made the basis on which the legal definitions of the electrical standards of E.M.F., current and resistance were established. His researches include work on the mechanical principles of flight, photography, the theory of the telephone, the distribution of alternating currents in conductors, and light. To him we are largely indebted for the establishment of the National Physical Laboratory.

Lord Rayleigh, indeed, died full of years and honours, most of the prizes and decorations specially awarded to scientists falling to him, amongst which was the Nobel prize for Physics, in 1904.

SENATORE MARCONI A PEACE DELEGATE.

The new Italian Ministry has selected Senatore Marconi as one of the Italian peace delegates. The illustrious scientist was appointed a Senatore by the King of Italy in 1915 and seems to be entering more and more into the public life of his country. It is surely most fitting that he, whose genius has so greatly contributed to the preservation of human life and the promotion of international communication, should now receive the signal honour of being made a peacemaker.

NEW APPOINTMENT.

Dr. Alfred N. Goldsmith, Professor in charge of electrical engineering at the College of the City of New York, has been appointed Director of Research of the Marconi Wireless Telegraph Company of America. Dr. Goldsmith is Editor of Publications for the Institute of Radio Engineers, and has recently written an important book on the subject of Radio-telephony.

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Correspondence

DEAR SIR,

Now that the wireless transmission of signals over many thousands of miles is a matter of daily occurrence, and when furthermore it has been proved practicable to transmit wireless signals direct from England to Australia, I shall be glad to have the advice of some of your more expert readers on a rather interesting theory which I have evolved.

I believe it is now generally accepted that for the purpose of radiotelegraphic transmission the earth may be treated as a conducting sphere over which the "base" of the wireless waves may be said to travel. It is also equally accepted that this conducting sphere is surrounded by another but larger sphere of conducting air known as the Heaviside layer. This conducting layer is situated, I believe, at a height of some 30 miles above the earth's surface. For the purpose of understanding my theory let us consider the case of a hypothetical wireless station situated at the North Pole. This station is presumed to have sufficient power to communicate with Australia. The waves radiated by this station would then spread out in rings in every direction and by the time they reached the Equator, they would consist of large rings of energy, the total circumference of the ring being equal to the circumference of the earth and the height of the ring 30 miles or the height of the Heaviside layer from the surface of the earth. These rings of energy would be vertical to the surface of the earth.

We now come to the most interesting point of all. On passing the Equator and, of course, still continuing between the conducting surface of the earth and the conducting inner surface of the Heaviside layer, the ring of energy commences to grow smaller until on reaching the South Pole the whole of the remaining energy (that is to say, the energy not absorbed by the surface of the earth and any intervening conductors) would concentrate at the South Pole and probably be reflected back again. According to this theory and provided that losses are not too high the strength of signals at the South Pole would be very much stronger than at the Equator.

I am now waiting to hear of the case of the poor wireless operator on board a steamer who quite innocently sails across the focus point situated exactly 180° from a larger power station such as Carnarvon, Arlington, Lyons or Nauen. It would not be at all pleasant to receive the concentrated energy from a big power station all at once on an ordinary ship's aerial. May not this theory account for some of the mysterious disappearances of ships which have taken place during the war, and which for lack of better evidence have been attributed to mines and submarines?

Yours faithfully, REDAX.

SIR,

To-day, the amateur is like a prisoner at the bar. He is awaiting the verdict of a scientific court martial. The jury (whoever such good men may be) know at the present moment exactly what their ultimate decision will be. Why then, don't they come from their recess at once and tell us whether we, the body of earnest pre-war pioneers, can once more take up a fruitful and fascinating research, or whether we are doomed to abandon for ever a labour of love. I ask you, is it fair that we should *all* be condemned, simply because we bow, without distinction, to the very vague and most misleading term "amateur"? It would surprise many of the officials who are to judge us, to learn that in the ranks of the so-called amateurs there are men whose word is an authority in the radio field. True, in this ever growing band of experimenters there exists a most regrettable personage, whose sole ambition and ability seems to be that of distorting the already over-worked aether, and inflicting upon his numerous victims an untiring bombardment of artificial atmospherics.

For the illustrious service which so many of these amateurs have rendered during the war, they are justified in demanding permission to "carry on." Let the men who hold our future in their hands be content to rigorously sweep out the non-technical novice, who *is* injurious to both the private experimenter and the commercial operator, but in regard to the real amateur—hands off!

I notice in the July issue of the WIRELESS WORLD certain veiled insinuations that although there is practically no doubt about the ultimate permission being granted to make use of "Spark Excitation apparatus," there is a possibility of the poor amateur being forbidden to indulge in C/W work. If such prophesy is fulfilled, well, the amateur may as well pack up at once, for it is upon the lines of C/W transmission and reception that the post-war experimenter intends to carry out a most fascinating research.

The one dominant thought of those who are eagerly awaiting their release from the restrictions of D.O.R.A. is Valves. The reason is obvious, because the introduction of the thermionic generator and rectifier of high frequency currents opens out a vast field of scientific exploration.

Last, but not least, without the assistance of C/W we are robbed of our interest in Wireless Telephony. Therefore, as a radio amateur myself, I appeal on behalf of my fellow students for an early gratification of a desire that is irresistible.

I remain, earnestly yours,

J. BALDERSTON.

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The Construction of Amateur Wireless Apparatus

This series of Articles, the first of which was published in our April number, is designed to give practical instruction in the manufacture of amateur installations and apparatus. In the following article the author deals with the important question of Inductances and Variometers. The Wireless Press, Ltd., has arranged with Marconi's Wireless Telegraph Co., Ltd., to supply complete apparatus to the designs here given, as soon as Amateur restrictions are released.

Article Five.—INDUCTANCES AND VARIOMETERS.

WITH regard to the shellac varnish we mentioned in the last article, unless the amateur decides to purchase the varnish from an electrical firm we recommend him to make it himself. Varnishes obtained from the ordinary colour shop, though labelled as "shellac varnish," are liable to contain ingredients other than shellac, which may entirely take away the insulating property when dry. The varnish should be made by dissolving shellac, and shellac only, in methylated spirit. It will be found that if a wide-mouthed bottle is filled with shellac and then spirit poured in to cover it, the resulting solution will be of about the right thickness for use. The shellac takes some time to pass into solution, but it is best not to attempt to hasten matters by applying heat.

Of course, enamel-covered wire need not be varnished. The covering is not hygroscopic and needs no protection from the air. Enamelled wire is particularly suitable for the construction of slider inductances. These are coils of variable inductance obtained by the sliding contact of a jockey on the turns of the coil. Only quite a narrow strip need be prepared along the track of the jockey. The enamel can be removed by means of sandpaper. A slider coil of this type is always rather a dangerous method of tuning the aerial circuit, as if a short wavelength is being received the slider will be near one end of the coil and the majority of turns will be out of action. These turns are, however, coupled with the inactive portion of the coil, and if the natural wavelength of the idle portion should happen to be the same as that being received, a pronounced rejector effect will result, with a consequent weakening of signals. It is always safer to tune the circuit by the employment of separate units of inductance, the necessary adjustment being obtained by the use of a variable condenser or variometer.

In the last article we dealt at some length with the construction of inductances for both transmitting and receiving circuits. We now propose to give the amateur some examples of the manner in which inductances may be used as variometers and couplings.

VARIOMETERS.

The word "variometer" is generally taken to mean a coil whose inductance

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can be varied continuously between certain limits. A tuning coil with step by step tappings or a sliding contact on the turns themselves is sometimes referred to as a variometer, but in practical wireless a continuous variation is generally understood to be implied when we speak of a variometer. A variometer is a particularly useful instrument to the amateur who does not wish to go to the expense of purchasing a variable condenser; the latter cannot be made very cheaply unless reliability and accuracy are sacrificed. Quite good wavemeters, for example, can be made by using a fixed condenser shunted by a variometer as the oscillatory circuit. The chief disadvantage lies in the fact that it is difficult to get a large range of wavelength with a single fixed condenser. This need not trouble the amateur, since of course the complete range of the wavemeter may be as large as desired by using a number of fixed condensers which can be connected in parallel one by one, a condenser being added for each range. By carefully choosing the correct capacities for the condensers the ranges can be made to overlap properly so that no blank series of wavelengths occurs over the whole range of the instrument.

The usual form of variometer for receiving circuits consists of two inductance coils connected in series electrically and arranged mechanically so that the magnetic field which the current causes in one coil is also linked with the turns of the second coil. Since the same current is flowing through both coils a field is also formed in the second coil, and consequently the total magnetic field linked with the circuit depends upon the physical position of the coils with respect to each other. Imagine, for example, that we have two formers, as indicated by (a) and (b) in Figure 1 placed axially opposite each other and of such sizes that one can be slid right inside the other. Then if we start with the formers as shown in Fig. 2, the series connection of the windings being arranged so that the magnetic fields due to the coils are in opposition, we shall obtain the minimum inductance possible with the coils under consideration. The inductance of the circuit will increase as the inside coil is pulled out, until the total inductance is equal to the sum of the seperate inductances when the distance apart is such that there is no appreciable mutual action between the windings. If now we reverse the connections to one coil and move them together again, the total inductance will increase until the maximum value possible is reached when the coils are again in the position shown in Figure 2. The

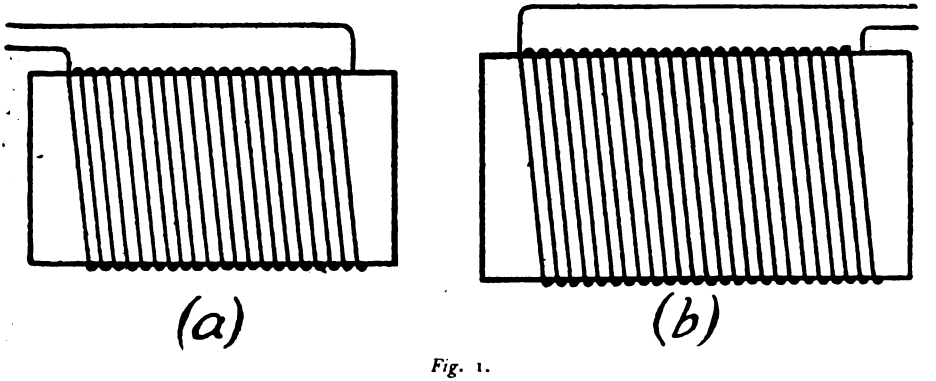

Fig. 1.

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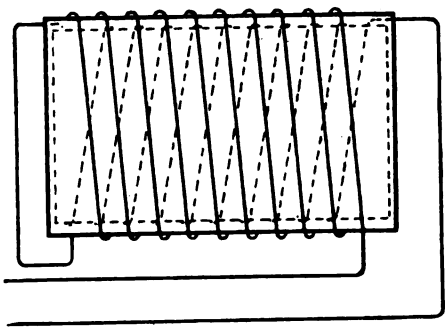

Fig. 2.

only disadvantage of this arrangement lies in the necessity of employing a switch to reverse one coil when in the "out" position in order to get the full range. A variometer of this simple type, i.e., two cylindrical coils sliding inside each other gives the largest change of inductance that can be realised in practice. If there were no magnetic leakage between the circuits in the "inside" position, it is theoretically possible, assuming the self-inductance of each coil to be the same, to get a variation from zero to four times the inductance of a single coil. This ideal case is not obtainable in practice as magnetic leakage always exists. In any case it is best to make the variometer so that each coil has about the same value of inductance.

The necessity of reversing one coil can be avoided by employing the construction indicated in Figure 3. This type of variometer consists of a short cylindrical former of ebonite wound with insulated wire. Inside this former a spherical coil is arranged so that it can be rotated on an axis along a diameter of the cylinder. Flexible leads are brought out from the ends of the spherical winding which is connected in series with the cylindrical inductance. The spherical coil is arranged so that it can be rotated through 180 degrees. It will be seen that when the axes of the two formers are coincident and the fields due to them oppose, we have the smallest inductance. Then as the inner coil is rotated until the fields are again coincident but in the same direction the inductance will gradually increase to its maximum value. This construction does not necessitate the use of a reversing switch because the act of turning the inside coil does the necessary reversal. A variometer of this type is not quite so easy for the amateur to make, since the inside former must be spherical in shape in order that it may be rotated without fouling the cylindrical former. These

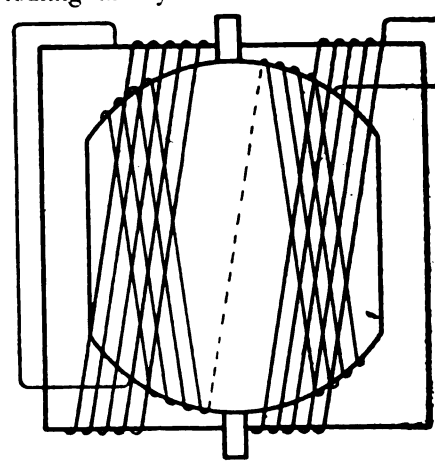

Fig. 3.

spherical formers can be purchased ready turned up and drilled for the spindle, and the rest of the apparatus is comparatively simple to construct.

Another form of variometer frequently employed consists of pancake windings as illustrated diagrammatically in Figure 4. In this figure A and B are two pancake windings connected in series. C and D are two similar inductances also connected in series. The two sets of coils are arranged so that C and D are carried by an arm which can be rotated about the centre O; so that when C is over A, D will be directly over B, and when C is

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over B, D is over A. If then the two pairs of coils are connected in series as shown in the sketch, it will be clear to the reader that we have in this system a variometer exactly similar to the one we have just described. The inductance will be a minimum when C and D are in such a position relative to A and B that the resultant field is a minimum, and the total inductance will increase as the top coils are rotated through 180 degrees. This type of variometer is more suitable for a transmitting circuit as the pancake windings can be done easily with rubber covered cable—whereas they are difficult to do with the fine wire such as is used in the circuits of a receiver.

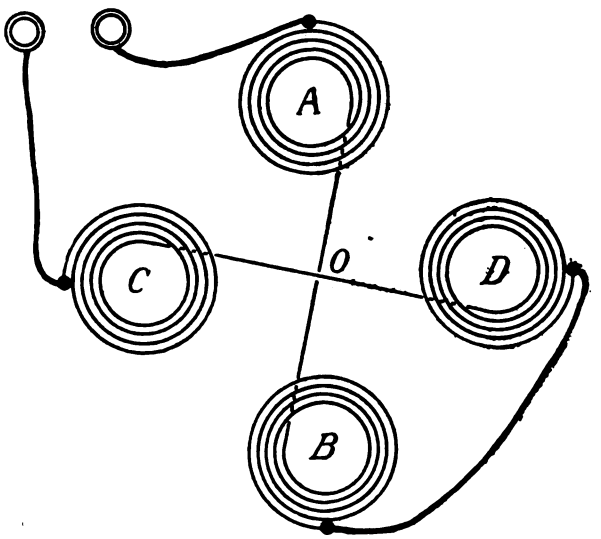

Fig. 4.

Couplings.

Of course the amateur will understand that any of the methods of changing the relative position of two inductances which we have just described can be equally well used as an adjustable coupling between two circuits. When making up experimental circuits on the table it is most convenient to lay the coils end to end. The coupling being adjusted by simply moving the formers nearer to or further away from each other. The arrangement can be made quite neat by making wooden rails for the coils to slide on. If the circuit is for transmitting, or has high potentials between the component parts care should be taken to use well seasoned and dry wood for the rails. In any case it is safest to soak the wood in paraffin wax before use. Also see that the coils do not come into contact with the metal screws used in the construction of the rails.

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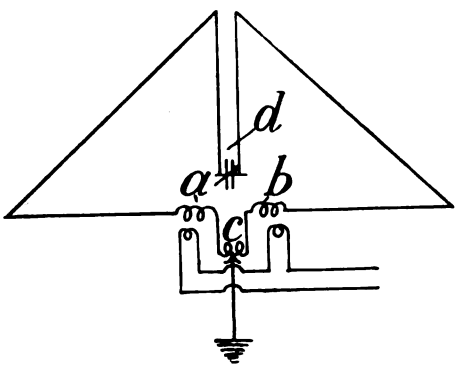
Patent Section

124,138. Wireless signalling. **Wright, G. M.**, Marconi House, Strand, London, July 18th, 1918. No. 11804 (Class 40 (v)).

Directive wireless signalling; aerials. In a directional aerial of the frame type, an adjustable condenser *d* located in an accessible position is connected to the top of the frame by a pair of symmetrical leads. In order to keep the transformer winding symmetrical and to make the earth connection readily adjustable to the potential node, a split transformer winding *a*, *b* is used, and an inductance *c* with an adjustable earthed contact is connected between the two parts *a*, *b*.

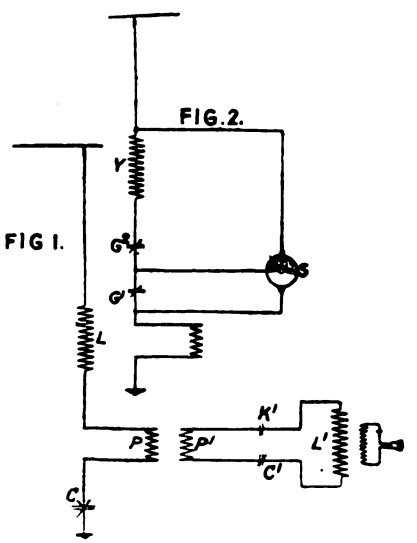


1402. Wireless telegraphy. **Clarke, E. R.**, 35, Leinster Gardens, Hyde Park, London, January 28th (Class 40 (v)).

In a method of tuning the aerial and secondary circuits, the secondary circuit contains a fixed capacity and inductance representing the aerial capacity and inductance, and the tuning-devices (capacity or inductance or both) in each circuit are operated by a single handle. In the arrangement shown in Fig. 1, the inductances *P*, *L* are equal to the inductances P^1, L^1, the condenser K^1 is equal to the aerial capacity, and the variable condensers *C*, C^1 are equal and operated by the same handle. In order to increase the range of wave variation, the aerial or the secondary circuit, or both, may contain an inductance *Y*, Fig. 2, and two variable condensers G^1, G^2 so arranged that, when one condenser is at its maximum capacity, the other is at or near its minimum. A switch *S* is mounted on the same shaft as the vanes of the condensers and is arranged to short circuit either the condenser G^1 or the condenser G^2 and inductance *Y*. Thus, when the switch *S* short-circuits the condenser G^1 and the condenser G^2 is at its maximum, the aerial is tuned to the maximum wavelength, and this can be continuously reduced by reducing the capacity G^2 until this reaches its minimum, when the switch *S* short-circuits this condenser and the inductance *Y* and removes the short-circuit from the condenser G^1, which is then at its maximum capacity; reduction of the capacity of the condenser G^1 then effects a further decrease in the aerial wavelength. The method of simultaneously adjusting the aerial

FIG. 2.

FIG 1.



and secondary circuits is also applicable to heterodyne systems for receiving continuous waves, a device for varying the frequency of the heterodyne circuit being mounted on the same shaft as that for varying the aerial and secondary circuits. The same method can be applied to receiving systems using audion detectors, the aerial, grid, and anode circuits being simultaneously adjustable. The Provisional Specification states that tuning may be effected by simultaneously adjusting an inductance and a series condenser mounted on the same shaft as the variometer, the circuit being thereby graduated on a straight-line law.

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Questions and Answers

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless telegraphy. Readers should comply with the following rules:* (1) *Questions should be numbered and written on one side of the paper only, and should not exceed four in number.* (2) *Queries should be clear and concise.* (3) *Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before.* **(4) The Editor cannot undertake to reply to queries by post** (5) *All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or if so desired, under a "nom-de-plume."* **(6) Will readers please note that as amateurs they may not at present buy, construct or use apparatus for wireless telegraphy or telephony. (7) Readers desirous of knowing the conditions of service, etc., for wireless operators, will save time by writing direct to the various firms employing operators.**

I.M. (Wiltshire).—From the questions our correspondent asks it seems to us that he has not yet done much experimental work in wireless, and that he is somewhat ambitious in trying to control a model boat by wireless. However, we trust that when I.M. does start work he will not be discouraged by a few initial failures. We are of the opinion that with a well-designed transmitter, a ½-in. spark coil, and a good coherer and relay, our friend should be able to control up to about 50-100 yards.

(2) It would be possible to have two receiving sets to respond to different wavelengths, but these receivers will have to be well designed in order that they shall only respond to their particular wavelength.

(3) What size spark coil would be required to transmit a distance of 40 miles, *using the latest apparatus?*

Where does our correspondent intend to use the latest apparatus, at the transmitting or receiving end? I.M. does not seem to realise that a spark coil of only a few watts will be heard over a much greater distance when received with, say, a three electrode valve amplifier, than if received on an ordinary crystal receiver.

With the latest type receiver a coil of about 40 watts would give good signals over a distance of 40 miles.

(4) Radiodynamics (The Wireless Control of Torpedoes and other Mechanism), by B. F. Miessner (Crosby Lockwood & Son, 7, Stationers' Hall Court, Ludgate Hill, E.C.), may be helpful.

A.M. (North Finchley).—Wishes to know: (1) the necessary formula for finding the length of wire required for a coil for a desired wavelength when capacity of condenser and length of wavelength are known.

(1) If the aerial is small it can be considered as concentrated capacity without inductance, so that the formula $\lambda = 1885 \sqrt{L\,(mhy)} \times C\,(mfds)$ may be used knowing the capacity of the aerial the necessary inductance of the tuning coil can then be calculated. If A.M. will refer to our answer to G.B. (Plymouth) in the June issue of the WIRELESS WORLD, he will there find the method of arriving at the capacity of the aerial.

Having found the required inductance, the following formula is used to find the length of wire required when wound on a circular coil:

$$L = \frac{\pi^2 n^2 d^2 l k}{1000} \quad (mhy)$$

where n = number of turns of wire in 1 centimetre length of coil
l = length of coil in centimetres
d = diameter of coil in centimetres
k = a factor depending on the ratio of the diameter of the coil to its length,

When $\frac{d}{l}$ =	.1	.5	1.0	1.5	2.0
k =	96	81	.69	.6	.53

A curve can now be drawn connecting the inductance and the length of several windings to find the length which gives the desired inductance.

(2) We are inclined to think that the size of wire you propose using for your secondary coils is on the small side and suggest your using about No. 28 if you are using a crystal detector. You will also find this gauge easier to wind. No. 24 for the primary would be suitable.

(3) If our correspondent will refer to the WIRELESS WORLD of May, 1915, or to W. H. Nottage's Calculation of Inductance and Capacity, page 123, he will find a table, worked out from the above formula, giving the inductances of coils of various diameters and lengths and from this table it is a simple matter to find a coil which will give the desired inductance.

If our coil of 16 cms. diameter is wound with 10 turns to the centimetre and is 26 cms. long, then the inductance will be 5152 mhys. If the coil is wound 20 turns to the centimetre,

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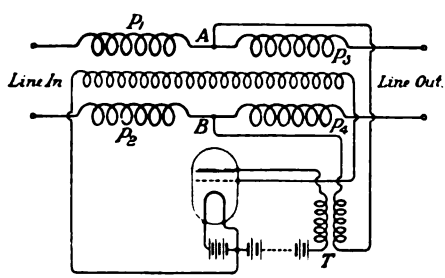
then the inductance of a coil of the same diameter and length will be

$$\frac{20^2 \times 5152}{100} = 2\ 608\ mhys$$

We strongly recommend A.M. to obtain W. H. Nottage's book, as it would prove most useful to him in the calculation of aerial capacities, inductances, and other necessary calculations for wireless investigation.

D.J.M.C. (Edinburgh).—We think it extremely unlikely that any employer would appoint you as a wireless operator for two months, because you would leave the job just as you were beginning to be useful.

E.P.B. (France).—(1) It is possible to insert a three-electrode amplifying valve at each end of a telephone line, to act as a "speech relay," provided that it is connected in the circuit of the receiver only, so as to amplify only the incoming signal. This arrangement is not the most usual one. (2) and (3). The most useful arrangement of the valve relay is in the centre of the telephone line, unless the line is very long, when several repeating stations may be inserted at approximately equal intervals between the extreme ends of the circuit. This arrangement has been used for the long overland telephone lines in America. When only one valve is used as the repeater in this manner special "bridge" circuits must be used to enable the repeater to work in both directions, *i.e.*, to relay speech from either end of the line. Many such circuits have been devised, and one typical one is shown in the Fig.



The original speech current passes through all the primary windings P_1, P_2, P_3, P_4, in series, and so induces a voltage on to the grid of the Valve V through the secondary winding *S*. The amplified current from the plate circuit of the valve is fed through the medium of the transformer *T* across the two lines at *A*, *B*. This amplified current passing out to the lines flows through the two pairs of primaries in opposition and so produces no resultant effect on *S*. If this balance is not secured continuous oscillations would be set up by the valve and the line would be unworkable.

J.V.M. (Manchester).—(1) and (2). Obviously the best way is for you to apply direct to firms manufacturing wireless apparatus. We think you should be able to find the job you require, but we have no inside information.

J.H. (Hawick).—At present the field for wireless operators is the reverse of overcrowded, and we advise you to complete your course as soon as possible.

H.S. (Nr. Congleton).—(1) Most commercial wireless operators on board ships have to purchase their uniform. (2) The wearing of spectacles will not debar you from obtaining a position as a wireless operator if your sight is by that means rendered good.

AERIAL RADIO (Marquise).—(1) You do not state to what Company you refer. We do not think that there exists at present a demand for wireless operators or wireless mechanics solely for aircraft work. (2) Neither are there, to our knowledge, any vacancies for telephony or D.F. operators. See Note 7 at the head of these columns. (3) We think not, but Marconi's Wireless Telegraph Company specialises in wireless telegraphic apparatus for aircraft. Thanks for kind remarks and good wishes.

J.C.J. (Bow).—There are only a few such firms, mostly railway companies, and these select men already in their employ. Why not apply to the Marconi International Marine Communication Co., Ltd., Marconi House, Strand, W.C.2. Please see Note 4 at the head of these columns.

EXPERIMENTER (Dukinfield).—Questions 1 and 2. You give diagrams of two circuits and ask whether they are suitable for certain purposes. We regret we cannot pass an opinion, because the suitability of a circuit for transmitting a given distance or for receiving on a given wavelength does not depend upon the diagram but upon the values of the power inductance, capacity, etc., employed, none of which you specify.

SHARE MARKET REPORT.

The Marconi Share Market has been dull owing to settling by holders who wish to subscribe to the New War Loan.

Prices as we go to press (July 16th):—Marconi Ordinary, £5 10s. od.; Marconi Preference, £4 15s. od.; Marconi Marine, £3 5s. od.; American Marconi, £1 9s. 9d.; Canadian Marconi, 16s. 9d.; Spanish and General, 14s. od.

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WANTED the following numbers of the "Wireless World":—April, June, 1913; June, July, 1917; January, February, March, April, May, September, 1918; February, 1919. Write with full particulars, price, etc., to Box N. Wireless Press Ltd., Marconi House, Strand, W.C. 2.

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Company Notes.

THE MARCONI INTERNATIONAL MARINE COMMUNICATION COMPANY (LIMITED)

THE REPORT OF THE NINETEENTH ORDINARY GENERAL MEETING

The Nineteenth Ordinary General Meeting of the Marconi International Marine Communication Company (Limited) was held yesterday at the Cannon Street Hotel, E.C., Mr. Godfrey C. Isaacs (managing director) presiding.

The Secretary (Mr. H. W. Corby, F.C.I.S.) read the notice convening the meeting and the auditors' report.

The Chairman said:—Ladies and gentlemen, our chairman, Senatore Marconi, having been called by his Government to Italy on important business, is unable to be present to-day, and therefore I am called upon to preside at this meeting.

The report and balance sheet are in your hands, and I presume you will approve of my adopting the usual course of taking them as read. I will therefore proceed at once to deal with the figures in the accounts. If you will refer to the balance sheet, the capital account at the end of the year stood at the same figure as it did at the end of 1917. You are, however, aware that this year the capital has been increased to one million and a half, of which to-day some £1,200,000 has been issued. The Debentures stand at £111,340, as compared with £112,280 in the preceding year, 47 Debentures of a par value of £940 having been redeemed. The reserve account is unchanged, except that there now appears a reserve for obsolescence of plant of £50,000. No comment is needed upon the creditor balances.

TRAINING OF OPERATORS.

To profit and loss account £105,417 10s. is carried forward from the preceding year, and the balance for last year was £186,341 17s. 1d., making the total £291,759 16s. 1d. The profit for the year shows a slight reduction, but this is due entirely to a considerable expenditure incurred in providing and training a very large number of operators in a very short time. It was a matter of the utmost importance to the country that these operators should be provided, for as everybody knows the Mercantile Marine and the wireless upon the ships played a very important part in helping to win the war, and your directors did not hesitate to expend whatever sum was necessary to provide within the shortest time possible what was asked of them. In these circumstances I feel sure that no shareholder will complain that notwithstanding the fact that the company did a substantially bigger business during the year, a proportion of the profit was sacrificed to the service of the country. (Hear, hear.) On the credit side of the accounts it will be seen that plant, apparatus, furniture, and stores shows a substantial increase over the preceding year, which is entirely due to the increased number of installations installed and owned by the company on board ships. Otherwise, I think there is no figure calling for any explanation on the credit side of the account.

THE PROFIT AND THE DIVIDEND.

In the profit and loss account the gross profit figures at £563,205 7s. 3d., as compared with £470,657 16s. 7d. in the preceding year, an increase of £93,000 in round figures, the net result, however, being less for the reason I have already stated, and which appears in the item of £267,707 15s. 2d., under the heading of "expenses of ship telegraph stations, including loss of plant and apparatus and cost of training operators." Depreciation, of course, stands at a higher figure in consequence of the continuous increase in the number of installations. In the appropriation account it will be noted that an interim dividend of 5 per cent. was paid on the capital as it stood at the end of 1918, which absorbed £50,000 and, subject to your approval, the final dividend of 10 per cent. upon the paid-up capital will require in round figures a further sum of £120,000. The balance of £141,759 16s. 1d. will be carried forward, and is subject to excess profits duty for the years 1916, 1917, and 1918, which has not yet been finally adjusted.

WIRELESS AND SHIPS.

As the report informs you, the company's business has continued to increase. The number of stations installed and worked by the company at the end of the year was 2,549, and stands to-day at 2,638. Taking into consideration the large number of ships which have been lost during the war, I think we have every reason to be satisfied with our position. We now look forward to the benefit of our telegraphic receipts, of which, as as you are aware, we have been deprived during the last four-and-a-half years. Having regard to the very much larger number of vessels now fitted with wireless telegraph stations, the great increase in coastal stations, and above all, the greater acquaintance which the world at large has to-day of wireless telegraphy, we have every reason to hope that our telegraph stations on board ships will be more freely used in the future than they were in the past. I will not prophesy what may be the development of wireless telegraphy upon ships as a result of navigation of the air.

THE DIRECTION-FINDER.

We think it probable, too, that an additional source of revenue to the company will arise from the more general use on board ships of what is known as the direction-finder, which has now been so very materially improved that it gives promise of proving of considerable value to navigators. That, together with the latest invention of Senatore Marconi, promises to prove a great boon to navigation. This new discovery provides a means whereby a ship in the densest fog may discern the approach of another ship, provided that that ship be also fitted with this apparatus, and at the same time giving an approximate idea of the distance of the approaching ship. We are at present engaged in giving a commercial shape to this new apparatus, and as soon as possible its value on board ship will be demonstrated. We have great hopes that by this means all risk of collision at sea during the thickest fogs will be eliminated, to which end, of course, every ship would have to carry the apparatus, for it stands to reason that if a great liner were fitted and a small tramp were not, the danger of collision and the loss of one or the other, or both, of the ships might result. Inasmuch as this new device should provide means of disposing of that which is so great a danger in misty and foggy weather, it is not unlikely, we think, that every ship which goes to sea will be eventually fitted with this new installation, and we shall all be spared the harrowing accounts of the terrible losses which from time to time it has been so distressing to read in the daily Press resulting from some terrible collision at sea. For all these matters some considerable capital expenditure is likely to be necessary, and we have made all the requisite provision for those purposes.

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LOSS OF OPERATORS DURING THE WAR.

I much regret having again to report the loss of a considerable number of operators during the past year in consequence of enemy action. During the war over 800 wireless operators in our employ were torpedoed or had their ships sunk by gunfire or striking mines, 182 of them lost their lives, and 38 were severely injured. I am sure that no men in any capacity did greater service to their country than the wireless operators, and I think we have every reason to hope that the long period of anxious and dangerous work is now a thing of the past, and that in future they will carry on their vocation under peaceful and more pleasant conditions. (Hear, hear.)

The company now employs upwards of 5,000 wireless operators, a large number of inspectors in all parts of the world, and a very considerable clerical staff, all of which are growing in numbers almost day by day. One of the first considerations of your board is to provide for the well-being, good understanding, and contentment of the employees of the company, and they have already done, and are doing, a great deal to this end. To encourage thrift, a savings bank has been formed for the purpose not only of taking care of the savings of the men, but also of furnishing facilities for the withdrawal of moneys at any of the principal seaports of the world. A welfare department has been established to look after the social, athletic, and educational interests of the men; and a service magazine is now about to be published to keep all employed in the service wherever they may be situated acquainted with the doings of the company and their fellow-members of the staff. All these are matters to which during the war we were unable to give the attention which we felt they required, but from the moment the Armistice was declared they were taken in hand. You will remember, of course, that prior to the war a pension scheme was inaugurated, and to-day there is one thing further which your board is desirous of introducing.

SHARES RESERVED FOR EMPLOYEES.

We think it is of the first importance that every man employed in the company should have the opportunity, if he so wishes, of investing his savings in the business in which he is employed, and we, therefore, propose, and subject to its not meeting with your disapproval, reserving for and issuing from time to time in all 100,000 of the 300,000 unissued shares of the company, to all those employed in the company who desire to interest themselves in it. (Hear, hear.) This exclusive, of course, of the directors and the managing director. We ask, therefore, for your approval of our carrying out this programme and disposing of these shares at such a price, and on such terms and conditions, as the directors may think fair and proper in the circumstances.

MR. ALLEN'S APPOINTMENT AS JOINT GENERAL MANAGER.

I have to inform you that Mr. H. W. Allen who, as you know, was appointed a member of the board last year, has, at my request, resigned the secretaryship of the company in recent months after having occupied that position since the incorporation of the company in 1900, and he has, at my request, assumed the joint general management of the company with Mr. W. W. Bradfield, also now, as you know, a member of the board. (Hear, hear.) From my own knowledge a great many shareholders have been acquainted with Mr. Allen in his capacity as secretary and have appreciated, as highly as the board have done, the service which he has rendered during a great number of years, and particularly through the most trying and difficult period of the company's history, and I am sure you will join with us in giving him, as joint general manager, all the support and confidence which he received from you during the time he acted as secretary. (Cheers.) Mr. Corby, who has been so good a second to Mr. Allen during many years, has been appointed secretary to the company in Mr. Allen's place. (Hear, hear.)

THE LATE PUBLIC TRUSTEE AND THE BOARD.

I regret to have to inform the shareholders of the loss which we have suffered in recent weeks by the death of Mr. Henry Spearman Saunders, who had been a director of the company since its formation. I have also to inform you that Sir Charles Stewart, K.B.E., who is known to all of you in connection with the very important position which he held for many years as Public Trustee, has joined our board, and we look to him with great confidence to render us substantial assistance in the efficient discharge of the responsibilities which we carry in the conduct of this business. (Cheers.) I conclude, gentlemen, by moving, "That the report of the directors submitted, together with the annexed statement of the company's accounts at December 31st, 1918, duly audited, be received, approved, and adopted."

Mr. Maurice A. Bramston seconded the resolution, and in the absence of questions or remarks from shareholders, it was at once put to the meeting and carried unanimously.

RE-ELECTION OF DIRECTORS.

Captain H. Riall Sankey, C.B., R.E. (retired).—Gentlemen,—I have great pleasure in submitting the following motion: "That Mr. Sidney St. J. Steadman and Sir Charles J. Stewart, K.B.E., the directors retiring in accordance with Article 67, re-elected directors of the company." It is quite unnecessary for me to say anything in support of that motion. I also have to move: "That Mr. Henry W. Allen, Mr. William Walter Bradfield, and Mr. Maurice Alfred Bramston, the directors retiring by rotation, be re-elected directors of the company." You have already heard to-day about Mr. Allen and Mr. Bradfield. Mr. Bramston is before you and you all know him quite well. I have great pleasure in moving their re-election.

Mr. Alfonso Marconi formally seconded the resolution, which was unanimously agreed to.

The Chairman.—I have now to move a resolution in similar terms to the one which was submitted to you last year, and which it is our custom always to put, namely: "That the remuneration of the directors in respect of the year ending December 31st, 1919, shall be the sum of £5,000, subject to such further sum, if any, as may be determined at the next general meeting of the company, such sum to be paid free of excess profits duty, the company waiving its right of recovery of such duty under section 49 (2) of the Finance Act, 1916." That resolution is similar to the one you were good enough to pass at the last meeting.

Mr. Sidney St. J. Steadman having seconded the resolution, it was carried unanimously.

THE DIVIDEND RESOLUTION.

Mr. Henry W. Allen, F.C.I.S.—I have pleasure in moving "That a final dividend of 10 per cent., equal to 2s. per share, less income tax, upon the capital now issued and paid up, be and the same is hereby declared for the year ended December 31st, 1918. That the said dividend be payable on July 14th to the shareholders registered on the books of the company at June 19th, and to holders of share warrants to bearer."

Mr. W. W. Bradfield, C.B.E., seconded the resolution, which was carried unanimously.

Mr. C. B. Clay.—I move "That Messrs. Cooper Brothers and Co. be re-elected auditors for the ensuing year, and that their remuneration for auditing the accounts to December 31st, 1918, be 400 guineas."

Mr. A. B. Croft seconded the resolution, and it was unanimously carried.

The Chairman.—That concludes our business for the day.

Mr. Wharton Marriott.—Gentlemen, I think we ought not to part without according a hearty vote of thanks to the chairman and the board, and also to all the officials who have served the company so extremely well that no words of gratitude from us would really make up for it. I move that our thanks be given to them. (Hear, hear.)

Mr. John Evans seconded the vote, which was unanimously agreed to.

The Chairman.—Gentlemen, on behalf of my colleagues and all the officials of the company, I thank you for your vote of appreciation.

The proceedings then terminated.

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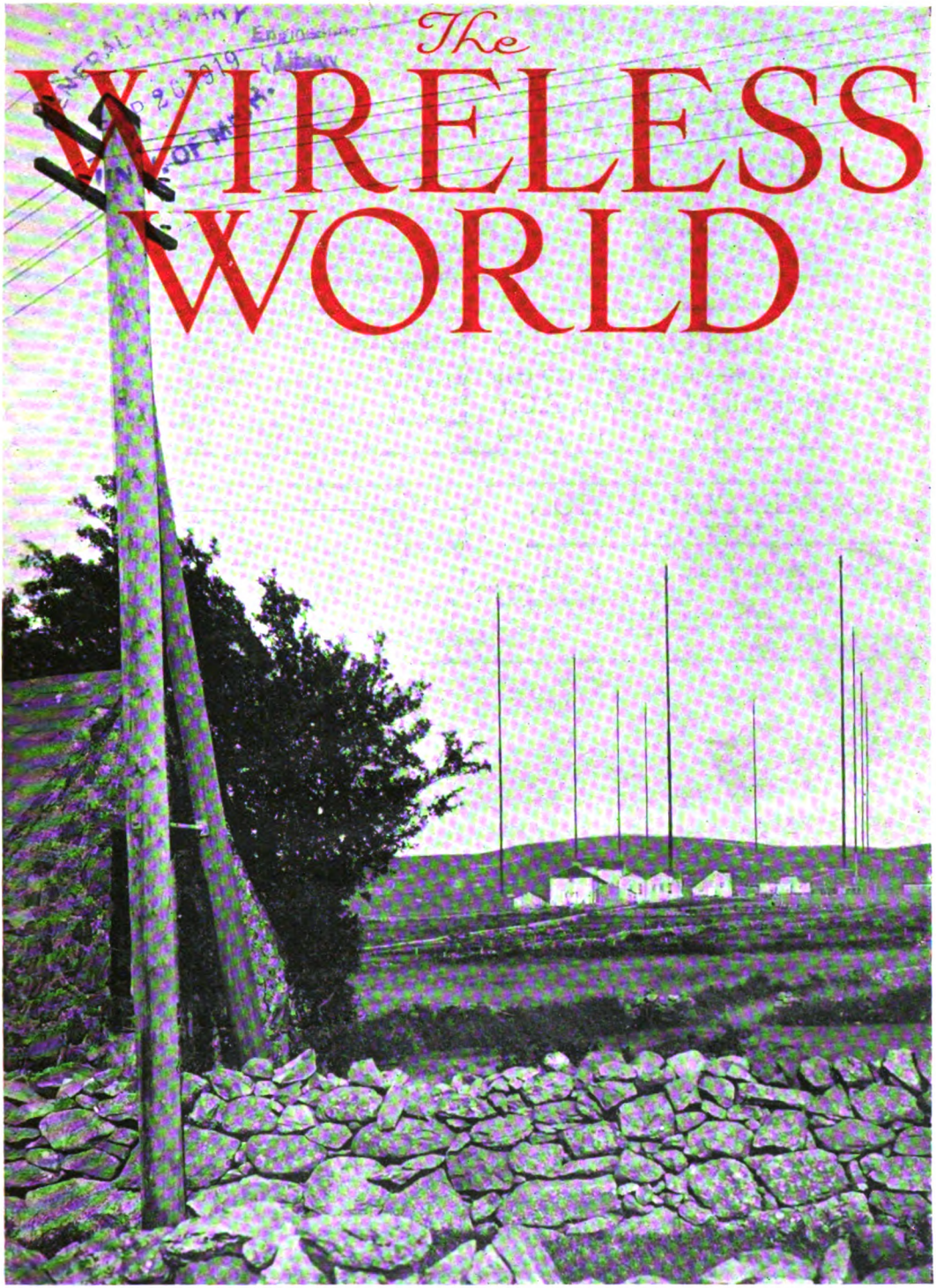
The WIRELESS WORLD



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THE
WIRELESS WORLD

No. 78
Vol. VII

SEPTEMBER,
1919

Great Wireless Stations

CARNARVON

THE Carnarvon Wireless Station is situated at Ceunant, Llanrug, five miles from the historic town of Carnarvon. Built on the site of Cefn Du, 800 feet above the sea level, it commands a magnificent view of the Menai Straits, and on very clear days, of the Wicklow Hills. To the eastward, along the line of the aerial, the ground rises about 1 in 10 to the top of the hill which is 1,450 feet high. The last set of masts supporting the aerial is 1,100 feet above the sea level and at this point a fine view of the Snowdon Range is seen, the Snowdon Peak being about six miles distant.

The station of which we write has already been described in a previous issue of the WIRELESS WORLD, but we are now able to give many more interesting details of the arrangements there, especially with regard to the powerful new transmitting plant recently installed.

The aerial is of the Marconi directional type, so arranged that the maximum radiation is in the direction of New Brunswick, New Jersey, with which station commercial service will shortly be carried on. The wires, of which there are 20, are of 7/18 silicon-bronze, the breaking strain of which is 1,300 lbs. Each wire is 3,600 feet long and is separately hung by insulators from steel triatics supported by steel masts 400 feet high. There are 10 of these masts supporting the four triatics which have an average length of 500 feet, the distances between the triatics being 900 feet. Owing to the greater strain at the ends of the aerial three masts are provided to support the end triatics (which are split into two), two masts being provided for each of the inner triatics. The natural wavelength of the aerial is 5,600 metres, and adjustable inductances to carry 300 amperes are provided for increasing this wavelength to 14,000 metres. The effective capacity of the aerial at the latter wavelength is .04 mfd and its resistance 2.1 ohms.

The electrical energy used for the wireless plant, heating and lighting, is obtained from the North Wales Power and Traction Co.'s Hydroelectric Station at Cwm-Dyli which is about two miles on the east side of Snowdon.

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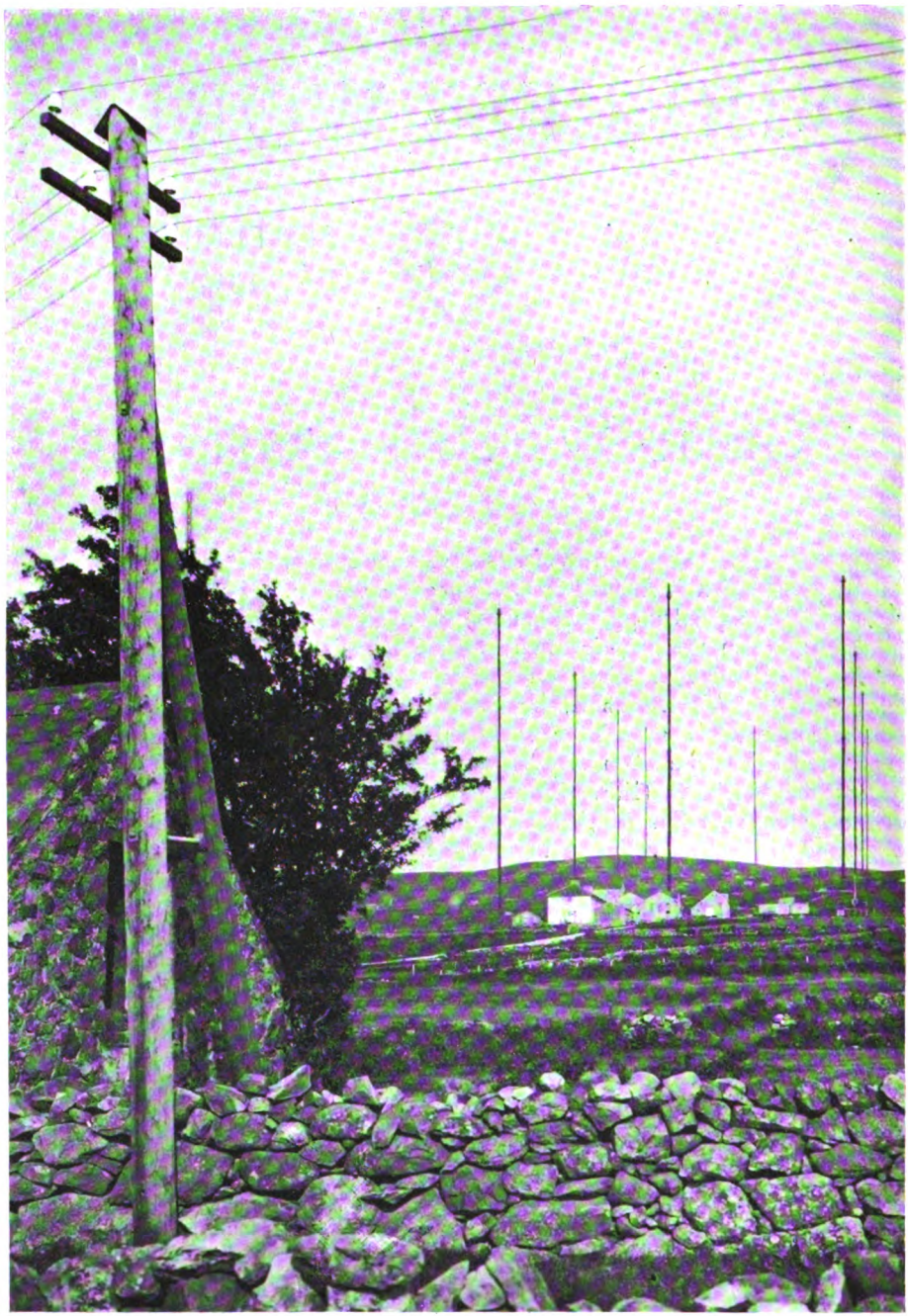

General View of Carnarvon Station.

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It is of interest to note that here is one of the few places in the British Isles where we are able to use "white coal" or the natural energy of falling water, for this power station utilises the waters of Llyn Llydaw which are led through pipes to the water turbines 1,000 feet below the level of the lake. The turbines are direct coupled, the 3-phase alternators generating at 10,000 volts supplying the slate and stone quarries in addition to the wireless station. Two aluminium power lines each of 500 k.w. capacity carry the current from the power station to the Marconi station, one being a line for the exclusive use of the latter, the other being the branch of a line supplying one of the slate quarries and used as a spare.

Station Buildings, Carnarvon.

At the wireless station two 500 k.w. transformers connected to each power line transform the current down from 10,000 volts to 440 volts at which power it appears on the main switchboard.

The main switchboard is of the Ferranti type and consists of 12 panels. From the feeder panel cables are taken to the nain switch panel on which is mounted a hand-operated oil switch provided with " no volt " and " overload time limit" releases, a voltmeter, ammeter, kilowatt meter, power factor meter and frequency meter. The remaining panels on the board are equipped with switches and gear for the control of the motors driving the high tension direct current generators, the motors driving the alternator sets, the motors driving the low tension D.C. auxiliary machines, the high tension alternators, direct current motors, and of all the lighting, heating and various other circuits.

There are three distinct types of transmitters installed (1) the synchronous alternating current sets; (2) Marconi " timed-spark " continuous wave machine; (3) the arcs.

The synchronous A.C. sets are in duplicate and are of 300 k.w. capacity, each consisting of a 450 B.H.P. 440 volt 3-phase asynchronous motor driving a 300-k.w. single phase alternator, the working voltage of which is 1750 volts. An extension of the alternator shaft drives the disc discharger through an insulating coupling. The primary condenser bank has a capacity of 2.5 mfds

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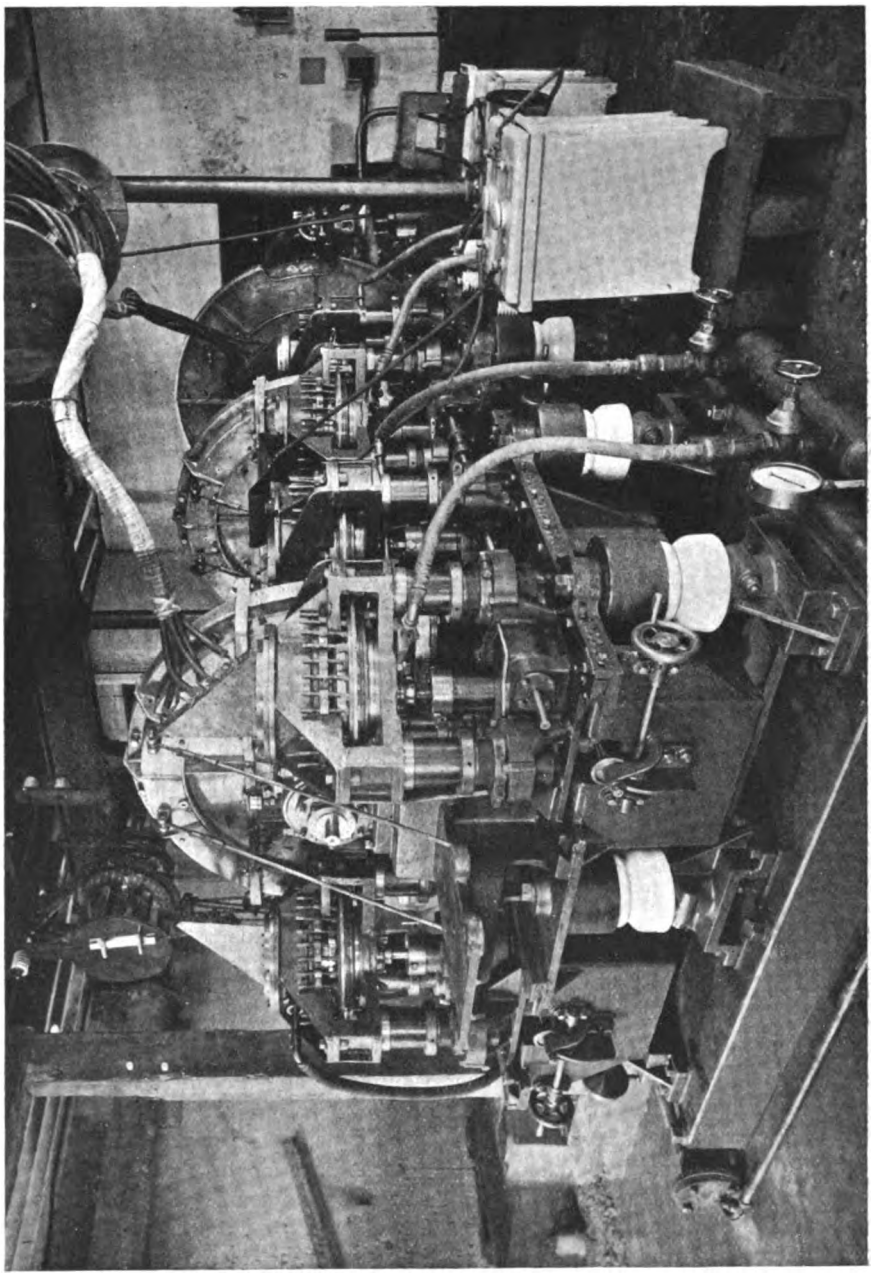

The "Timed Spark" Discharger.

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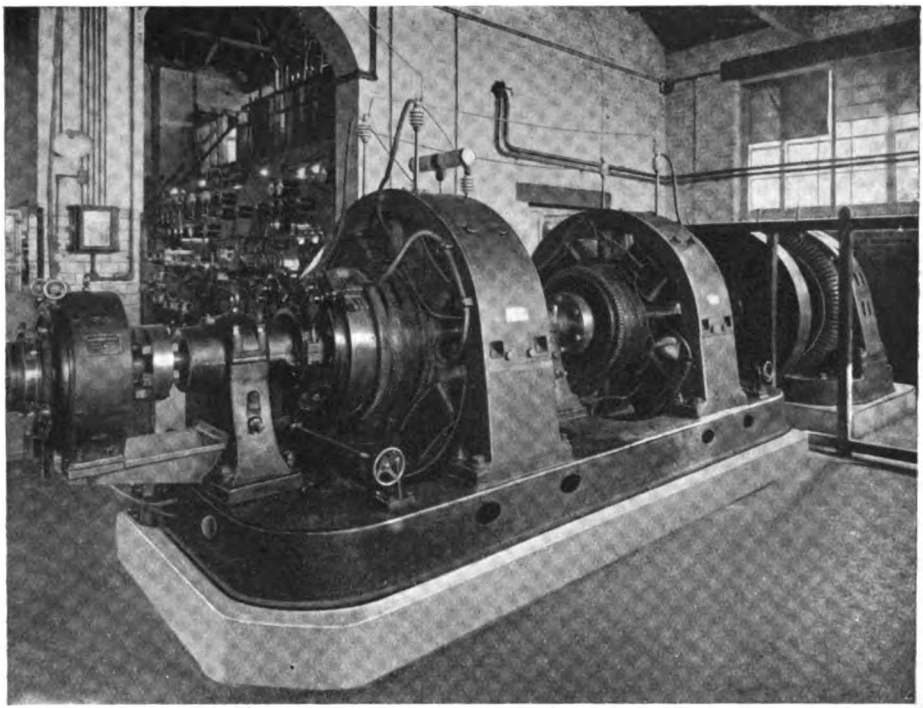
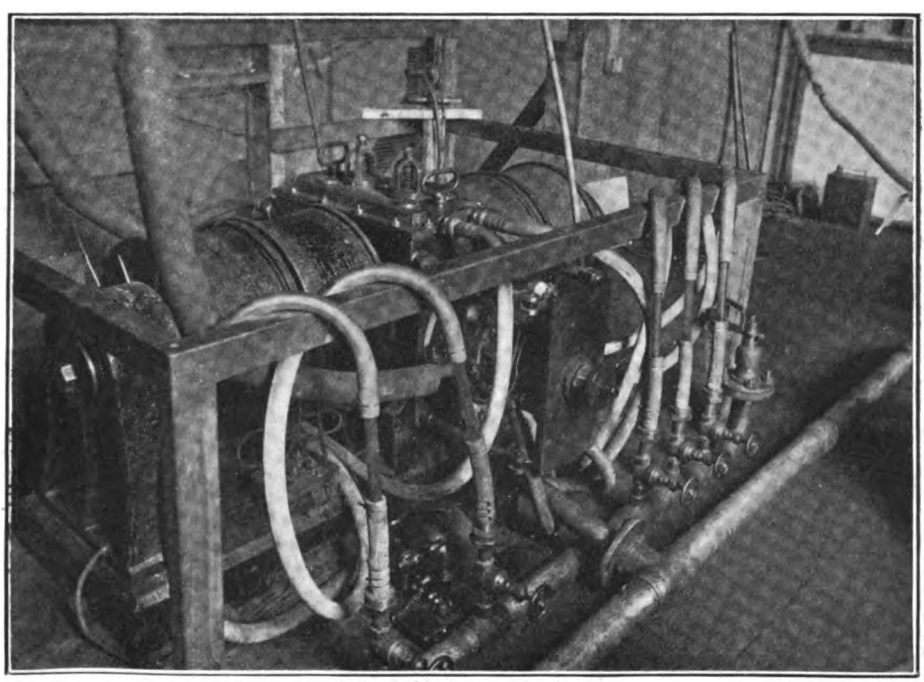


The Main Switchboard and some of the Machines.



One of the 200 K.W. Arcs.

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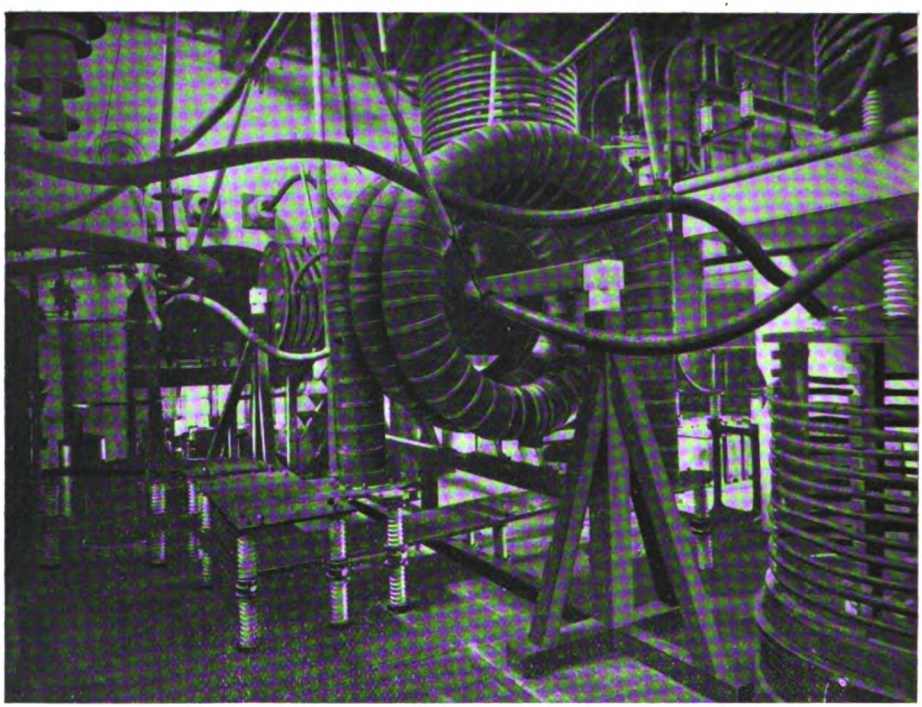

One of the Jiggers. Note the huge primary winding.

The Receiving Room, Towyn.

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and is charged by step-up transformers, the field of which can be adjusted so that the studs on the disc discharge the condenser at each peak of the alternation.

The timed spark continuous wave transmitter has two distinct primary circuits tuned to the same frequency and coupled to the aerial circuit. The condensers of these primary circuits are charged by 5,000 volt D.C. dynamos and discharged alternately by means of a special form of disc discharger so arranged that the trains of oscillations produced in the aerial by the successive discharges of the two condenser banks take place in phase with one another. This timing of the discharges is controlled by a trigger circuit which at a given instant ionises the gap between the studs and electrodes of the main circuits and enables them to discharge, special adjustments being provided for determining the moment of discharge. Signalling is effected by making and breaking the charging current of the trigger circuit, and as this current is only .5 amp. a very high rate of working is possible.

One of these transmitters of 300 k.w. capacity, capable of working at 200 words per minute, is already installed at the station and a duplicate set is in course of erection.

The 200 k.w. arcs are of the horizontal type and are fed through choking coils and starting resistance from a 800 volt D.C. dynamo. The field of the arcs is separately excited from an auxiliary 110 volt D.C. dynamo which also supplies current for the pump motors, cathode motors, and spirit relays. Methylated spirit is automatically fed into the arc chamber which, with its lid, anode and cathode, is water cooled, a relay being provided in the water circuit to cut off the current to the arc should the water supply fail.

A special receiving station at Towyn is intended for all the receiving and operating work, and is provided with apparatus for duplexing the service. At Carnarvon, however, for special war purposes, receiving apparatus has been installed with a range of from 3,000 metres to 16,000 metres. The aerial is inductively coupled to an intermediate circuit which in its turn is coupled to an amplifying and self-heterodyning valve circuit. By means of magnifiers in the telephone circuit arrangements are made for either automatic reception at high speed, or to enable the operator to receive without wearing telephones. The signalling key for operating by hand is placed in the receiving room, where there is also a Wheatstone automatic transmitter capable of working at a speed of 200 words per minute. For this high speed working high tension signalling switches worked by a Creed compressed air engine is used for slow transmission. Galvanometer type signalling switches are provided, but both types can be operated from relays, either by the hand key or by the Wheatstone transmitter.

Although the Carnarvon station is primarily intended to work to America our article would be incomplete without a reference to the fact that it has successfully communicated with Sydney, Australia, thus proving that it is powerful enough to cope with any distance up to the limit of possible long-distance transmission on the earth, it being understood that modern receiving apparatus is employed at the Antipodes.

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GENERAL GUSTAVE FERRIÉ.

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Personalities in the Wireless World

GENERAL GUSTAVE FERRIÉ, who was born at St. Michel de Maurienne (Savoy) on the 19th of November, 1868, is an old scholar of the Ecole Polytechnique (Paris). He commenced his experiences with wireless telegraphy in February, 1899, by being present during the experiments of Senatore Marconi in wireless working between Wimereux and Dover. Since that time he has continually devoted himself to the science of radio-communication. In 1900 he created the French Military Radiotelegraphic Service, of which he is now the Technical Director.

General Ferrié's personal contributions to the development of wireless are many and important, some of the most interesting being as follows:—

Measurement of wavelengths emitted by antennæ of rather small size and directly excited by means of a horizontal wire, shunted on the earth connection (nodes and loops) (1901). Thermic Ammeter, Wavemeter and adjustable condenser (1902-1903). Thermic Ammeter, Wavemeter and Variable Self Inductance (1902-1903). Direct Reading Wavemeter (two crossed needles) (1909). Several types of revolving dischargers. Tube-disc discharger (1909). Establishment, with Commander Brenot, of the first Automobile Wireless Stations and of the first stations on dirigibles and aeroplanes that ever existed (1909-1912). Installation of the Eiffel Tower Station (Experiments commenced in 1903). Installation for the transmission of time signals: Eiffel Tower Observatory of Paris (1910). Production, with the collaboration of MM. Claude and Driencourt, of a method of comparing clocks by wireless telegraphy by means of which were determined, notably in 1910, 1911 and 1913, the difference of longitude between Paris, Bizerta, Brussels, Washington, etc., with an approximation to the order of one hundreth of a second of time. Collaboration with M. Blondel for the establishment of processes of directional transmission and reception of wireless signals with open and closed frames (1901-1912). Collaboration with the same Physicist from 1902-1908 in the study of the use of alternating current in wireless telegraphy. The association (for the first time) of a closed frame and of an amplifier for long-distance directional receiving (Fort of Palaiseau, November, 1915). This frame has always been employed since that time in the reception of radiotelegrams by the great American stations. In addition to the above-mentioned works, General Ferrié has directed many researches, a few of which are hereafter mentioned:—Special valves which may be used as desired, as detector, amplifier or generator (carried out by M. Abraham) (1915). Special valves of various types (MM. Abraham, Beauvais, Jouaust, Brenot (1915-1919). Production of radiotelegraphic receivers for aeroplanes (carried out by Lieutenants Lévy and Gutton), October, 1915. Wireless telephony between aeroplanes and the ground (January, 1916). Carried out by Lieut. Gutton. Telemechanics: A vessel was able to be directed in the roadstead of Toulon by an aeroplane. Lieutenants Manescau, Guéritot, Brillouin and Abraham. Creation of the great Lyons Station (Captains Péri and Chaulard). In 1904 General Ferrié acted as the Official Representative of France at the International Electrical Congress at St. Louis, U.S.A. He has been the recipient of a very large number of decorations and other honours. He is an Officer of the Legion of Honour and an Officer of Public Instruction, a Commander of the Crown of Italy and an Officer of the White Eagle of Serbia. He has received the Medal for Distinguished Services (United States), and he is a Companion of St. Michael and St. George (Great Britain). Finally, it must be mentioned that a few months ago he was made a Doctor of Science, *honoris causâ*, of Oxford University.

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The Marconi Timed-Spark Continuous-Wave Transmitter

By PHILIP R. COURSEY, B.Sc., A.M.I.E.E.

THE generation of Continuous Oscillations such as are now so extensively used for radiotelegraphic signalling and are of such vital necessity for radiotelephony may be accomplished in a number of different ways. Of these the H.F. Alternator method is undoubtedly the most direct, but it is subject to a number of serious difficulties both mechanical and electrical, that greatly hinder its extended use. Until comparatively recently the Arc has been the source that has found most employment for this purpose, and some very large C.W. arc installations have been built. The Poulsen Arc system comprises the best known examples of such apparatus, and has recently been described in these columns*

In addition to the above we have "spark" methods and "valve" methods. The use of the three-electrode valve for the production of continuous oscillations of any frequency has been treated in considerable detail in a number of recent articles in this magazine. The Marconi continuous wave apparatus may be classified with the former of these two groups.

The production of a continuous wave from a damped spark discharge as source presents considerable difficulties. Chief amongst these is the fact that in order that the wave radiated from the transmitting station may be undamped, the radiating aerial circuit must receive a fresh supply of energy in *every* cycle of the oscillation. To accomplish this with a spark transmitter of the usual type would require an extremely high spark frequency of quite impracticable value.

A step in the right direction was made by the introduction of multiphase spark apparatus, in which several quenched or rotary spark gaps were employed, each working on a separate phase of the supply circuit, but feeding on to a common aerial circuit. In this manner the frequency of the discharges at each individual spark gap is reduced in proportion to the number of phases, although the resultant effective high-discharge frequency is maintained. To carry out this method in practice for comparatively short wavelengths (of the order of 600 metres) still, however, demands either a very high spark frequency or a large number of phases. For instance, a 600 metres wave has a frequency of 500,000 per second, so that even if 27 phases were employed the individual spark frequency would still be 18,500 per second, which is too high to be readily workable. By reducing the number of discharges to be an exact sub-multiple of the oscillation frequency it is possible to secure a fresh energy impulse to the aerial circuit once in every two, three or more oscillations instead of once in every one. The wave radiated will not then be quite undamped, but will still be continuous, although the amplitude will be waxing and waning slightly between successive spark discharges.

* Vol. VII., p. 8, April, 1919.

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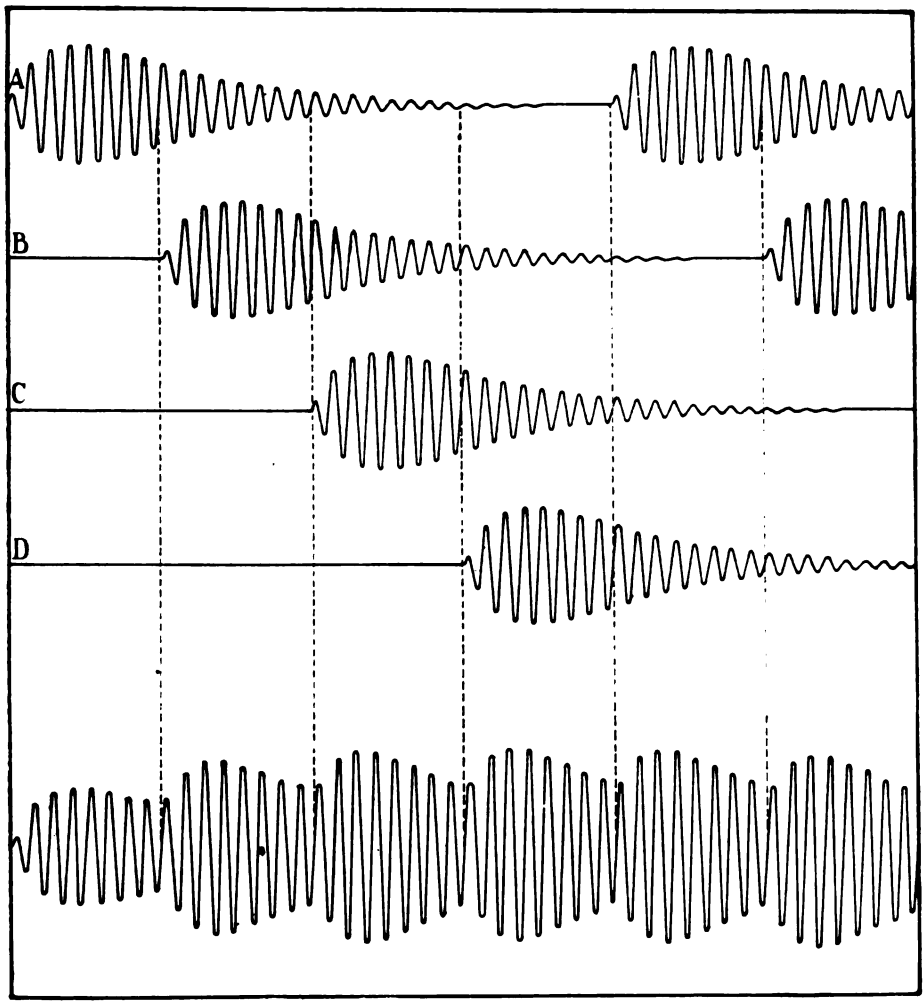

Fig. 1.

One of the chief difficulties experienced with these arrangements is that of ensuring that the successive discharges shall occur in the proper phase relation to the oscillations existing in the aerial circuit. If this phase coincidence is not secured the energy imparted to the aerial by one discharge may sometimes help and sometimes hinder the oscillations already existing. The magnitude of this effect is illustrated diagramamtically in Figs. 1 and 2.

These diagrams illustrate the case when the oscillation frequency is eight times the effective spark frequency. In Fig. 1 the fresh oscillation trains start exactly in synchronism with the aerial oscillations in each case, whereas in Fig. 2 the successive wave trains are displaced through half a period from the correct position. The poor quality of the resultant wave in the latter case is very evident.

It has been found experimentally

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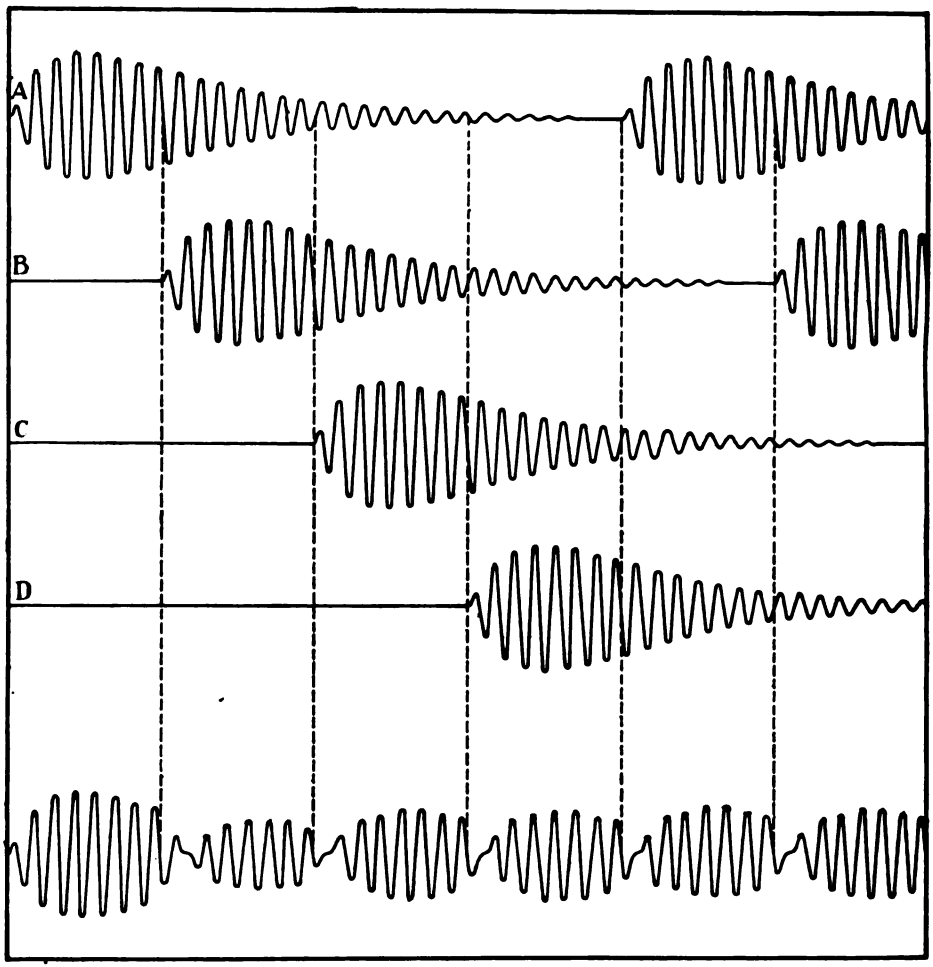

Fig. 2.

when using multiphase arrangements of the above type that the efficiency of the complete apparatus falls very considerably as compared with the value obtainable with one of the phases working alone. This is due to the irregularity in the synchronisation of the impulses and the consequent irregularity in the resultant wave form. These irregularities are also made manifest by the "hissing" that is heard in a receiver picking up the waves radiated from one of these sets.

The all-important feature of the Marconi continuous wave apparatus is the means provided for securing this correct synchronisation of the impulses, so as to ensure regular operation. A number of rotary disc spark-gaps are employed to provide the successive discharges in a similar manner to the multiphase apparatus discussed above, so that a high resultant discharge frequency is obtainable without increasing the spark frequency on each individual disc. The spacing of the teeth or studs on the discs

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is thereby retained at a reasonable figure to prevent the spark from flashing over to more than one stud at the same time.

Although the use of a rotary disc gap in place of a stationary quenched spark-gap provides much more regular operation and spark spacing, yet this alone is not sufficient to obtain the best results from synchronisation of the wave impulses, especially with high power sets. Means have therefore been provided with these installations for "timing" the main discharge to force it to commence at the correct instant of time in relation to the aerial oscillations. For this reason this apparatus is often referred to as the "Timed Disc Discharger."

The fundamental idea of the first forms of this apparatus was to employ several discs with a large number of studs, so that a fresh impulse could be imparted to the aerial circuit *once* in *every* oscillation. With high power sets working on long wavelengths this complication is unnecessary and a simpler arrangement using two main discs and one "trigger" or control disc is now employed. The general principle of the arrangement is illustrated diagrammatically in Fig. 3. The two main discs are shown at $D_1 D_2$ and are each provided with four sets of fixed electrodes, connected so that each discharge circuit is formed with four spark gaps in series, two on each disc. As can be seen from the diagrams, the fixed electrodes are set so that the successive discharges occur on opposite sides of the discs, and pass through the two main oscillation circuits C_1 L_1 L_2 and C_2 L_3 L_4 alternately.

The timing of the main discharges is effected by the trigger disc TD which is driven by the same shaft as the main discs. This trigger disc is provided with twice the number of studs as the main discs in order that the trigger discharges may be able to start off the main discharges on both sides of the main discs in succession. The trigger disc circuit is energised from the main supply generator G through the signalling key K. The trigger oscillation circuit C_7 L_7 is coupled to a high voltage closed secondary circuit C_8 L_8 which is tuned to C_7 L_7. From the terminals of this condenser, leads are taken through the quenching spark gap S to the central points of two pairs of small condensers C_3 C_4 and C_5 C_6 which are bridged across the main spark gaps as shown.

These condensers have a capacity of only about 1/30 that of the main condensers C_1 C_2 so that very little of the main oscillation current would pass through them. The oscillation frequency of the trigger disc circuits C_7 L_7 and C_8 L_8 is made very much higher than that of the main oscillations so that the high frequency trigger discharge current can easily pass through the small condensers C_3 C_4 C_5 C_6 to the discharging electrodes of the main discs. The trigger disc has only to deal with a very small power, so that the discharges are sharply defined.

The main spark gaps (of which there are four in series in each main discharge circuit) are about $\frac{1}{10}$" long, so that the voltage of the supply generator G (5,000 volts D.C.) is insufficient to break down the gaps. When, however, a spark occurs at the trigger disc, a high H.F. voltage is momentarily impressed upon the main discharge gaps, which are thereby ionised, so that the main discharge is suddenly precipitated.

In this way the main discharges can be spaced at perfectly regular intervals and exact synchronisation secured with the aerial oscillations.

An air blast is provided at each of the main gaps to rapidly quench out the spark after the first few oscillations.

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All signalling for telegraphic working is accomplished in the trigger circuit, since the main discharges are completely controlled by this circuit. The signalling key has therefore only to handle quite a low power.

It should be evident from the above that the speed of the discs must be carefully adjusted and maintained constant if the desired exact synchronisation is to be maintained. Fig. 4 shows the Control Engineer's desk at the Radio Station recently erected at Stavanger, Norway, where indicators are provided to show the exact speed of the discs, and control handles for regulating this speed. In Figs. 5 and 6 are views of a 300-kw. C.W. installation of the type described above. Fig 5 shows the two main discs with the larger trigger disc in the background on the right, while Fig. 6 is a view of the same installation taken from the trigger disc end. It should be noted from these photographs that the fixed electrodes are in the form of small revolving discs, to which the current is led by a number of flexible brush connections.

In the case illustrated, each main disc has 24 studs and the trigger disc 48, so that when one discharge has passed through the four gaps in series on one side of the discs, the next discharge will pass through the four on the opposite side at 1/48th of a revolution later. The speed of revolution = 1982.5 r.p.m., so that 793 discharges per second occur

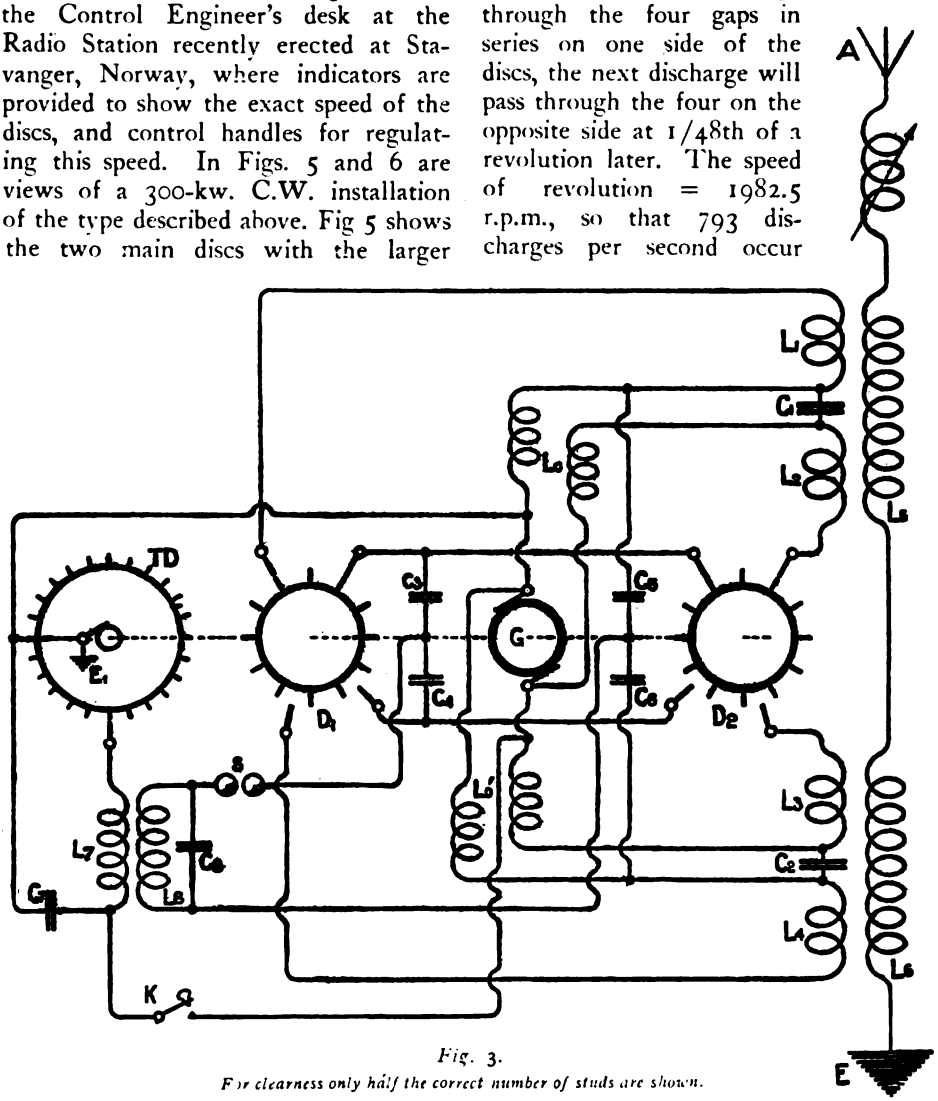

Fig. 3.

For clearness only half the correct number of studs are shown.

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Fig. 4—The speed control for the discs.

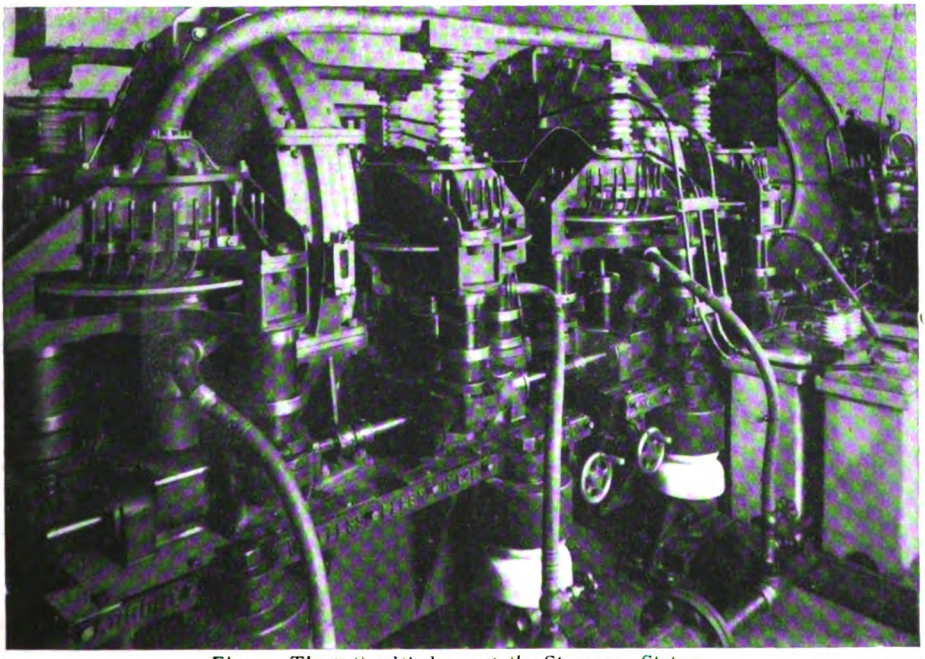

Fig. 5—The "timed" discs at the Stavanger Station.

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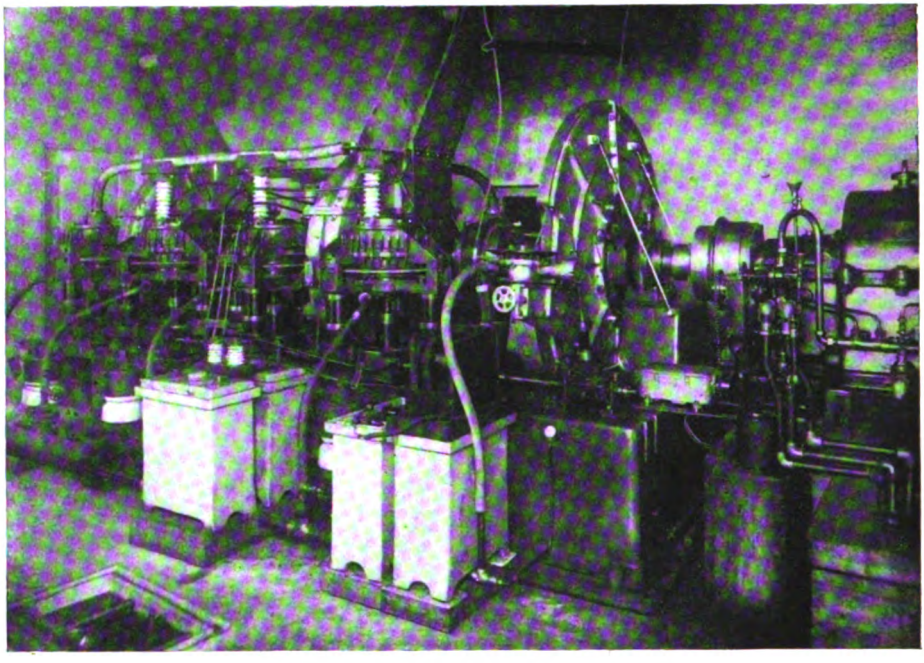

Fig. 6—Another view of the Stavanger discs.

on each side of the mains discs, making 1586 per second the effective sparking rate.

The main oscillation circuits and the aerial are tuned to a frequency of 21,400 ~ which corresponds to a wavelength of 14,000 metres. There are thus, $\frac{21,400}{1,586} = 13 \cdot 5$ oscillations in the aerial between the commencement of successive discharges at the main gaps. Hence assuming, say, that there are four oscillations in the primary during each discharge, we have 9·5 oscillations in the aerial between the end of one discharge and the commencement of the next. Taking the decrement of the aerial circuit for the case of these large Marconi aerials as about 0·02, we find that with an oscillation frequency of 21,400 ~, the amplitude of the oscillation will be reduced by the radiation and by the resistance losses, to about 82·5% of its initial value during these 9·5 oscillations. Hence it appears that in spite of the relatively long interval between successive discharges, the radiated wave is quite continuous, and only fluctuates a matter of about 13½% in amplitude.

The success of this simple method is evidently dependent upon the use of the very long wavelengths, since a spark frequency of 1586 would give quite a good note in the receiving telephones if used with short wavelengths, as there would then be such a large number of oscillations of the higher frequency between successive discharges that each wave train would die out almost completely before the commencement of the next discharge.

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Digest of Wireless Literature

By E. V. Appleton, M.A., B.Sc.

THE USE OF TREES AS ANTENNÆ.

In the June issue of the Journal of the Franklin Institute, Major-General George O. Squier, the Chief Signal Officer of the United States Army, gives the results of some of the interesting experiments made during the war under his supervision. In 1904 this experimenter made some preliminary tests with a view to utilizing growing trees as antennæ for radio-telegraphy, but owing to the lack of a sufficiently sensitive receiver these experiments were only partially successful. In the later experiments carried out at Washington it was immediately discovered that with the sensitive thermionic valve receivers now available it was possible to receive signals from the principal European stations by simply laying a small wire netting on the ground beneath the tree as earth and connecting an insulated wire to a nail driven in the tree well within the outline of the tree top. After testing variations of earth and antennæ connections it was found that the best results were always obtained by using an elevated tree connection terminal in the upper part of the tree top and an " earth " consisting of several short pieces of insulated wire sealed at the outer ends radiating from a common centre and buried a few inches below the surface of the ground in the neighbourhood of the tree.

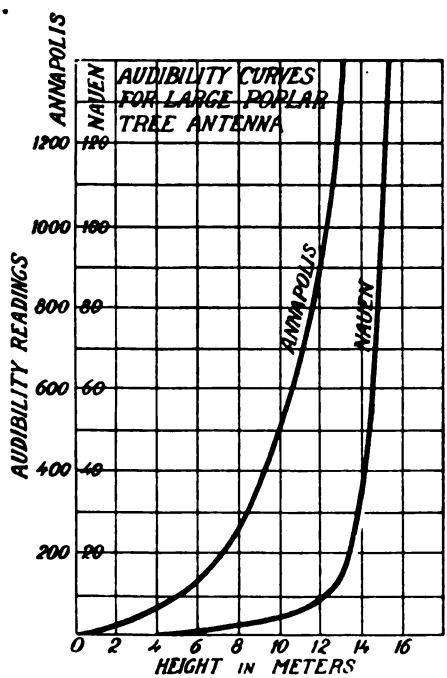

Fig 1

Experiments were performed testing the capacity and antenna resistance of such systems. The natural capacity was found to be proportional to the height of the contact with the tree. The antenna resistance was found to be many times that of an ordinary antenna, the range being from 2,000 to 26,000 ohms. Because of this high antenna resistance the design of the receivers had to be materially altered to utilize to the best advantage the energy impinging on the tree in the form of electromagnetic radiation, though it is stated that quite good results were obtained with receivers suitable for ordinary antenna. Miller has shewn that the presence of conducting material (e.g., a tree, buildings or wooden mast) near an antenna may increase the resistance of an antenna enormously, and it thus seems that the explanation of such large resistance values in the case of tree antenna is to be found in the effect of the immediate proximity of the partially conducting tree to the conducting lead. Some interesting quantitative experiments were made on the audibilities of

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signals from Annapolis and Nauen. A non-inductive resistance was placed in parallel with the telephone and its value reduced until the limit of audibility was reached when dots and dashes could just barely be distinguished. If t is the impedance of the telephone for the particular frequency and s the resistance of the shunt in the final adjustment the ratio $\frac{s+t}{s}$ gives the audibility.

A large poplar tree 18 metres high was used as antenna with a portable U.S.A. Signal Corps Heterodyne receiver and low frequency amplifier. The receiver set was in each case tuned to give best signal strengths and the audibility then found. The data obtained are illustrated by Fig. 1 in which audibilities are shewn as functions of the height of contact. It will be noted that a very great increase in audibility was found with heights of contact above two-thirds the height of the tree.

* * *

THE DETECTION COEFFICIENT OF THERMIONIC VALVES

By H. J. Van der Bijl.

Paper read before American Physical Society, March 1st, 1919.

MANY workers with thermionic valves must have felt the need of a satisfactory method of comparing quantitatively the high-frequency detecting efficiencies of various types of valves. No reliable information can be got from a consideration of the curvature of the static characteristic curve alone, as in most practical cases the effects of grid current (e.g., with grid condenser and high resistance leak) are all-important. It thus seems preferable to have recourse to direct experiment and a simple method of doing this was described by H. J. Van der Bijl at a meeting of the American Physical Society on March 1st, 1919. The theory of this method can be best approached by a consideration of the fundamental relations between current and voltage in a thermionic valve. The magnitude of the plate current depends in general on the potentials of the plate and grid with respect to the filament. But when the valve is acting as a rectifier the relation between grid voltage and the consequent plate current variations (plate voltage being assumed constant) is non-linear. Thus if an alternating E.M.F. of maximum value v be impressed between the filament and grid the alternating changes in the plate current of maximum value I may be represented for practical purposes by the empirical relation—

$$I = a_1 v + a_2 v^2$$

where a_2 is called the detection coefficient. When the valve is acting purely as an amplifier (i.e., working at conditions represented by the straight parts of the characteristic curve a_2 is practically zero and the relation between plate current and grid voltage is a proportional one, a_1 being the slope of the grid voltage-plate current characteristic.

For the determination of a_2 under conditions approximating as nearly as possible to those of a wireless receiver alternating currents of radio-frequency and of small magnitude must be employed and thus the use of hot wire instruments

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is out of the question. Moreover, it seemed preferable that the method of making comparison between the various signals should be a telephonic one. The apparatus used in the experiment of Van der Bijl is shewn diagrammatically in Fig. 2. The input voltage impressed on the tube at C ranged from a few hundredths to a few tenths of a volt and was measured by means of the Duddell galvanometer G frequency n with a variation of amplitude of audio-frequency n^1. Mathematically the voltage e may be expressed by the relation :—$e = A \sin 2\pi nt\ (1 + \sin 2\pi n^1 t)$. With the change-over switch in position (a) a note of audible frequency n^1 is heard in the telephone. The current causing this note is too small to measure accurately by any instrument, but its magnitude can be arrived at by matching it with a known fraction of a much larger measurable current. This large current of audio-frequency n^1 is supplied by a generator U and its magnitude is measured by means of a thermo couple and micro-ammeter A. By means of the shunt S a known fraction of this current passes through the telephone when the switch is in (b)

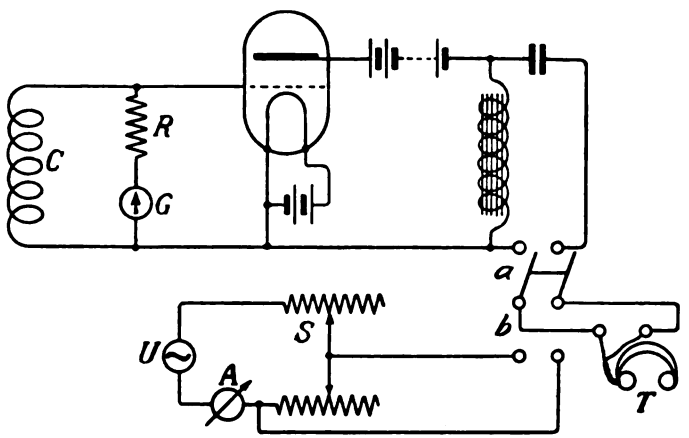

Fig. 2.

position. The shunt S is adjusted so that the signal intensity is the same for both positions of the switch. Thus in the equation $I = a_2 v^2$ (the part $a_1 v$ being neglected as it does not contribute to the detecting action of the valve) both I, the fraction of the current supplied by U and the input voltage v are known, and therefore a_2 can be calculated.

It was found that similar results were obtained by two different observers in matching the two notes in the telephone. A certain valve in use for seven months was not found to alter in detecting efficiency to any noticeable extent during the whole period. The detection coefficient of this particular tube was found to be 36×10^{-6} amp/volts^2, the resistance of the telephone receiver being 6,400 ohms. This corresponds to a power dissipation in the telephone of $8{\cdot}3 \times 10^{-6}$ watt/volts^4. An idea of this amount of power in the receiver can be obtained by noting that the minimum power dissipation necessary in this particular receiver to give a sound that just barely enables one to distinguish signals is about 3×10^{-12} watts.

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THE NATURAL CONSTANTS OF WIRELESS ANTENNÆ.

A Meissner, *Physikalische Zeitschrift*, March 15th, 1919.

IN the *Physikalische Zeitschrift* of March 15th, 1919, A. Meissner gives a list of empirical formulæ for the determination of the natural wavelength of certain common forms of aerials. Taking the simplest case of an earthed vertical wire we may write $\lambda_0 = 4l$ where λ_0 is the fundamental wavelength of the unloaded aerial and l the length of the wire (see Fig. 3) (a). In the case of more complicated aerials formulæ similar to the above (i.e., always of the form $\lambda_0 = Kl$ where K is a factor of proportionality) are available, the length as shewn in Fig. 3 always being the full length of the aerial, including the lead-in. For the same antenna capacity the greater the ratio of antenna capacity to antenna inductance the greater the factor K. An increase in the surface area of the antenna also leads to an increase in K.

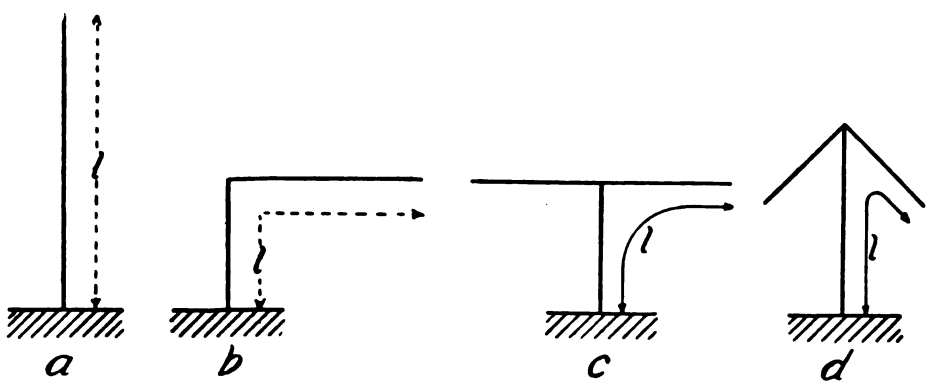

Fig. 3.

The following table gives the numerical values of K in relation $\lambda_0 = Kl$ for various forms of antennæ :—

⌐-Antenna 1 metre from the ground	K = 5
⌐-Antenna with a breadth of $\frac{l}{2}$	K = 5 to 7
(e.g., for high ⌐-Antenna at Nauen K = 5.5)	
Narrow T-Antenna of a ship	K = 4.5 to 5
Broad ⌐-Antenna (e.g., for T-Antenna at Nauen)	K = 5.8
Still broader T-Antenna (e.g., breadth = l, height = $\frac{l}{2}$)	K = 9
Ordinary Umbrella Antenna depending on the number of wires	K = 6 to 8
Low Umbrella Antenna (with height less than $\frac{l}{3}$) with many wires	K = 8 to 10

In the June issue of the Proceedings of the Institute of Radio Engineers J. M. Miller deals with the same subject in a less simple but more exhaustive manner. The aerial-ground portion of an antenna C.D in Fig. 4 is treated as a line with uniformly distributed inductance, capacity, and resistance. The lead-in is considered as being free from inductance or capacity except when inductances or condensers are specially inserted.

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If L_1 is the inductance per unit length, C_1 the capacity per unit length and l the length of the aerial it can be shown that the fundamental frequency of the aeria. is $\frac{1}{4\sqrt{l C_1 \times l L_1}}$ (i.e. $\frac{1}{4\sqrt{L_0 C_0}}$ where L_0 and C_0 are the total inductance and total capacity respectively). The wavelength in this simple case is equal to four times the length of the aerial. The wavelengths of the harmonic oscillations of the antenna bear in this case a definite ratio to the length (e.g., second harmonic $\frac{4}{3}\,l$, third harmonic $\frac{4}{5}\,l$) and the harmonic frequencies are multiples of the fundamental frequency.

The most important practical case is, however, that in which an inductance is inserted in the lead-in. If the value of this be L the mathematical theory yields the relation $\frac{\cot 2\pi n\sqrt{C_0 L_0}}{2\pi n\sqrt{C_0 L_0}} = \frac{L}{L_0}$ where n is the frequency of the natural oscillations of the loaded antenna. This equation cannot, however, be solved directly, but numerical tables can be constructed whereby the natural frequency n can be calculated when L_0 C_0 and L are known. (The reader will find these numerical tables in the paper referred to and also in Circular 74 of the Bureau of Standards obtainable from the Department of Commerce, Washington, price 60 cents.)

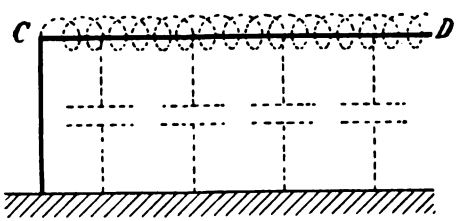

Fig. 4.

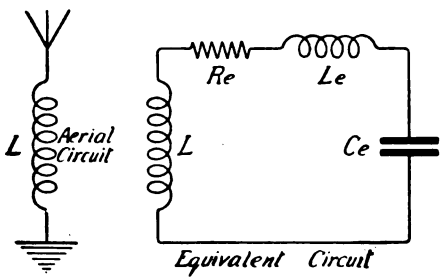

Fig. 5.

As an example of the method let the length of the antenna be 60 metres, the static capacity C_0 be ·0008 microfarads, and let the value of L_0 equal 50 microhenries. If now an inductance L of 100 microhenries is introduced in the lead-in we have $\frac{L}{L_0} = 2$. From the table we find that when $\frac{L}{L_0}$ is 2 we have $\frac{2\pi l}{\lambda} = ·653$. Thus the wavelength may be calculated, and is found to be 577 metres. Thus introducing the inductance has increased the wavelength from 240 to 577 metres.

The case of a condenser of capacity C inserted in the lead-in can be considered in the same way. In such a case the relation between the natural frequency n and the other constants is $-\frac{\tan 2\pi n\sqrt{C_0 L_0}}{2\pi n\sqrt{C_0 L_0}} = \frac{C}{C_0}$

Numerical tables can also be constructed for the solution of this equation. Thus in the above illustrative example if a capacity of ·0005 microfarads is inserted in the lead-in the fundamental wavelength is shewn to be decreased from 240 to 172 metres. In quantitative wireless work it is very often necessary to replace an aerial with distributed capacity and inductance which also

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has a loading coil L in the lead-in by an equivalent circuit consisting of the inserted inductance in series with lumped resistance Re, inductance Le and capacity Ce (see Fig. 5). In practice the quantities which are of importance in an antenna are the resonant wavelength or the frequency and the current at the current maximum. The quantities Le and Ce are therefore defined as those which will give the equivalent circuit the same resonant frequency as the aerial circuit. Also a second condition is that quantities Le, Ce and Re must be such that the current in the equivalent circuit will be the same as the maximum in the aerial circuit for the same applied E.M.F. whether damped or undamped oscillations are used. The mathematical work leading to the evaluation of Re Le and Ce is very complex, but the simple practical result which emerges is most useful. It is shewn that the effective low frequency resistance and inductance are each one-third of the values which are normally obtained by calculation considering the current as constant throughout the aerial, and that the effective low frequency capacity is the same as the capacity as calculated in the ordinary way.

We thus have:—

$$Re = \frac{R_o}{3}$$

$$Le = \frac{L_o}{3}$$

$$Ce = C_o$$

It is of interest to note that the two values for the effective inductance and capacity are in agreement with those obtained by an entirely different method by Prof. G. W. O. Howe in the Yearbook of Wireless Telegraphy and Telephony, page 699, 1917. The ordinary formula for the frequency of oscillation of circuits with lumped inductance and capacity may be applied in this case if we assume that the inductance and the capacity are the same at all frequencies, and we thus have to a high degree of approximation

$$\lambda m = 1884 \sqrt{(L + \frac{L_o}{3})C_o}$$

where λm indicates the wavelength in metres, inductance is expressed in microhenries, and capacity in microfarads. Applying this to the numerical example worked out above by the exact theory in which $L + \frac{L_o}{3} = 116{\cdot}67$ microhenries and $C_0 = .0008$ microfarads we have $\lambda = 575$ metres which differs only by one-third per cent. from the value 577 metres obtained before. It is, of course, possible to calculate C_0 and L_0 from the ordinary formulæ, but they may readily be determined experimentally if a standard wavemeter is available by the familiar method of determining the wavelengths λ_1 and λ_2 when two inductances L_1 and L_2 are separately inserted in the lead-in. It is easy to shew that in this case

$$L_o = \frac{3(L_1\lambda_2^2 - L_2\lambda_1^2)}{\lambda_1^2 - \lambda_2^2}$$

The value of C_0 can be obtained by substituting for L_0 in either of the formulæ

$$\lambda_1 = 1884 \sqrt{(L_1 + \frac{L_o}{3})C_o}$$

$$\lambda_2 = 1884 \sqrt{(L_2 + \frac{L_o}{3})C_o}$$

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The magnitude of the effective constants of an aerial circuit may also be determined experimentally if sources of both damped and undamped waves are available. When a source of undamped oscillations in a primary circuit induces an E.M.F. E_0 in a secondary tuned circuit the current in the secondary depends only on the resistance R of the secondary and is given by $\frac{E_0}{R}$. If damped oscillations are supplied by the source in the primary the current in the secondary for a given E.M.F. and primary decrement depends upon the decrement of the secondary, i.e., upon the resistance and the ratio of capacity to inductance.

These facts suggest a method of determining the effective resistance, inductance and capacity of an antenna at a given frequency in which all of the measurements are made at one frequency.

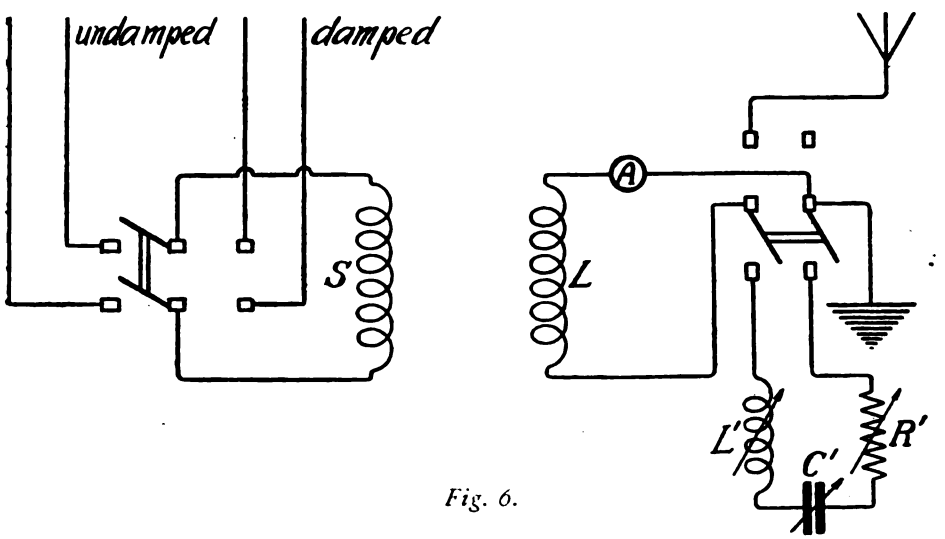

Fig. 6.

In Fig. 6 S represents a coil in the primary circuit which may be thrown either into the circuit of a source of damped or undamped oscillations. The coil L is the loading coil of the antenna which may be thrown over to the measuring circuit containing a variable inductance L^1, a variable condenser C^1 and a variable resistance R^1. First, the undamped source is tuned to the antenna and then the circuit tuned to the source. The resistance R^1 is then varied until the current is the same in the two positions when $R^1 = Re$. Next, the damped source is tuned to the antenna and the change in the current noted when the connection is thrown over to the L^1C^1 circuit. If the current increases, the value of C^1 is greater than Ce and *vice versa*. By varying both L^1 and C^1 keeping the tuning the same and R^1 unchanged, the current may be adjusted to the same value in both positions. The effective capacity Ce is then given by C^1 and the effective inductance Le by L^1. The measurement requires steady sources of undamped and strongly damped current. The former is readily obtained by using a vacuum tube generator. A resonance transformer and magnesium spark gap operating at a low spark frequency serves satisfactorily for the latter source. An accuracy of one per cent is not difficult to obtain.

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Twice Across the Atlantic in Ten Days.

By Lieut. R. F. Durrant, R.A.F.,

Wireless Officer of the R34.

I REMEMBER some years back, August, 1911, when the predecessor of the Wireless World—the *Marconigraph*—first published details of the wireless on an aeroplane; it seemed to us then that wireless was reaching the climax of its wonderful history. Now only eight years later I wonder what you, students of the æther, will think of the last word in ætheric communication that lies behind the little door of the wireless cabin on H.M. Airship R.34—commanded by Major G. H. Scott, R.A.F. He has indeed demonstrated in a wonderful way the future of Rigid Airships by flying with a crew of 32 a distance of over 3,000 miles, landing safely, refuelling and returning to an appointed aerodrome in England, all in the space of ten days.

On R.34 there are four gondolas each with engine—the control car being forrard and here the Commander, Navigator, and Coxswains are on duty—the latter controlling the rudder and elevators.

Just in the entrance between the engine unit and the chart table is the wireless cabin. It is approximately seven feet square and fitted with table, cupboards, and two windows. The aerial is provided by a long trailing wire beneath the ship, wound on a neat wooden reel and released when the ship attains a height of one thousand feet. The whole of the metal hull, cars, and steel guys are used as the balance capacity.

For long distance transmission spark is not favoured owing to the danger of fire, and we use the now well-known system of undamped waves produced by the vacuum valve—to which is also attached a wireless telephone unit, capable of efficient speech up to 80 miles. For communication with merchant ships I used a small aircraft 100-watt transmitter, which proved very useful. In fact, never once did I call C.Q. when speeding along in that mysterious cloud world above the vast Atlantic, without receiving an answer from some ship, be she tramp or liner, all anxious to know of our welfare and progress.

When working the continuous wave transmitter great care has to be exercised to secure the maximum efficiency—and hence the valves particularly are carefully nursed to secure the best results. We worked St. Johns from a distance of 1,800 miles, receiving strength being good and clear. Surely the day is now coming when spark will make way for the silent continuous waves.

From England to New York not a ship was sighted until I got into wireless touch, and afterwards saw on our starboard bow the S.S. Seal outward bound for Australia. "GOOD, GOOD, O.M.," was what the Seal's spark crackled out and then " I've wasted six films on you, om." " Not wasted, I hope, om," I morsed out, and very aptly

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he replied " Not for future generations, I hope."

Then came our worst experience, in the Bay of Fundy, with electrical disturbances. The good ship was taken out of our hands by an unseen power and hurled from 5,000 to 2,000 feet before answering the helm again, the air hot, and sparks leaping from the aerial as I quickly reeled in, the whole atmosphere alive as with demoniac ferocity.

How the R.34 came through only Providence knows—but those who saw the wonderful handling by her Commander felt an inward thrill at his triumph over Nature. And then came the fear of petrol shortage, and the wireless call for U.S. destroyers to stand by, which was unfortunately misinterpreted in England as a distress signal; but the good ship sped on, and we reached New York under our own power.

The reception by the American authorities was one of the outstanding features of the flight; nothing was too much trouble for them, from providing clothes, to fêting us in " little old New York." It indeed made us feel that a new tie had been created between the two great English-speaking peoples.

Lieut. R. F. Durrant, R.A.F.

Much had to be done while on the ground, the sets overhauled and batteries recharged, although quite a lot of charging was done " en route " with a small charging board from the Brolt dynamo driven off the forrard engine.

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Only four days there and the weather experts informed us we must leave that night as a great storm was coming from the region of the Great Lakes. We floated over New York at 1,500 feet and the sight that met our gaze is imprinted on our minds for ever; a veritable kaleidoscopic vision of light, interspersed with the searchlights of the United States battleships in the river, which shone now on our glistening hull, and then on the faces of the multitude below. It provided a scene which was almost intoxicating in its novelty.

Then the good craft's head was turned for the East, and with a 40-knot breeze behind us, and with only three engines running we were speeding to Blighty at 80 miles an hour. The cheery little meals in the crew space amidships, the chestnut of "who stirred the mustard with the toothbrush?" and the ragtimes on the Decca gramophone all showed the lighter side of the great flip, and when the giant masts of Clifden wireless station showed up against the evening sunset we all grinned broad grins.

I cannot conclude without thanking the Marconi Company for their magnificent help in placing their great Clifden and Glace Bay stations at our disposal; time and again the aerial cruiser was warned of bad weather ahead by wireless reports from Clifden, and their aid was of incaluable value. I wish to mention, too, how Cape Race received my little spark set at 250 miles—which I believe creates a record. To Canso wireless station for great help and to all others who stood by so well, best thanks.

Whilst over Norfolk preparatory to landing, H.M. the King's gracious message came through and its effect when read on board was as a tonic. The lessons learnt on this voyage will enable Great Britain to maintain her supremacy of the air.

Corporal H. Powell.
Lieut. Durrant's assistant during the voyage.

From the operating point of view the following items may be of interest. The High Tension voltage for the C.W. Transmitter was supplied by a very neat motor generator, specially constructed by Messsrs. Newton, and giving a variation of voltage from 1,100-1,500 volts.

For long distance work we used a $3\frac{1}{2}$-h.p. Douglas engine driving a larger motor generator situated in the engine room, this giving 2,000-3,000 volts.

The spark set worked on a 16 volt. battery which with a double pole switch could be used either for spark or lighting the filament of the valves.

A three-valve receiver was used for reception and with this Clifden was read right up to Nova Scotia—true note—and with the receiver oscillating, much further.

Severe atmospherics burnt two pairs of telephones out, and I have much to write on this at a later date.

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Stray Waves.

THE AMATEUR POSITION.

UNHAPPILY the situation in respect to amateur radio work remains unresolved, indeed the cancellation of all previously-existing amateur licences is a step backwards, although it may be the preliminary to a speedy settlement of the vexed question. This clean sweep of licences clearly shows that the Government has drastic alterations in view and intends to make an entirely fresh start. Anyhow, one seems to apprehend that the long-suffering amateur is doomed not to regain his pre-war footing.

To our way of thinking the wrong policy is being pursued. The wireless amateur should be encouraged, not shackled, restricted and shown the "cold shoulder." The country badly needs the brains of enthusiastic men who are prepared to follow up vital scientific subjects at their own expense and as a labour of love. The more minds there are applied in this country to the many outstanding problems of radio-communication the better, for young, keen America, painstaking Germany, and brilliant Japan are all in the field, to say nothing of Senatore Marconi's compatriots and those fine electricians, the French.

When war broke out the authorities were glad enough to avail themselves of the skill and experience of amateurs, and a shining example of what these amateurs are worth is that of Lieut. R. F. Durrant, the R.34's Wireless Officer, who was formerly a member of the North Middlesex Wireless Club.

We have before us a cutting from the *Daily Express*, a part of which reads as follows, " . . . said an official of the General Post Office to a *Daily Express* representative, we are very careful to see that applicants are not simply out for amusement. Before the war we had a good deal of trouble with silly fools who apparently asked their best girls to tea and amused them by sending out ' S.O.S.' signals on their wireless sets. Now that there have been such improvements in the apparatus inanities of this kind will be very obstructive to messages of commercial importance."

All we have to say with regard to that statement is that any practical wireless man knows how the "fools" could be soon discovered and eliminated; no ban has been placed upon private motor-cars simply because a "fool" occasionally runs over a pedestrian. As for amusement, we should like to know why people may not amuse themselves in any way they please, provided they do not infringe the liberties of other citizens or transgress against the law. The amateur is willing to be supervised and to conform to reasonable regulations; he is even willing to act as a policeman of the æther amongst his own class, but judging from the look of things there exists a desire to obliterate him altogether. America has bowed—stiffly, it is true—to Prohibition, but she did not agree to the proposal to stifle amateur wireless telegraphy. Why should you? What are the Wireless Clubs doing to defend their rights? It was the American amateurs themselves who won their day, though they interested their legislators in the matter. Have our Wireless Clubs knowledge of any Member of Parliament who will stand up for them in the House?

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GERMAN INFLUENCE OVER DUTCH WIRELESS.

The Bandoen Correspondent of *De Locomotief* writes: If ever the history should be written again regarding the realisation of wireless telegraphic communication between the Dutch Indies and Holland and *vice versa*, thereby revealing the whole truth, one will then learn some very interesting details. We base this statement upon the fact that we have been successful in throwing some light upon the erection of radio stations in the Indies regarding which during the course of time we have collected material which shows clearly what a remarkable attitude the Dutch Government has taken up in this matter. It may be that in some points we are not fully accurate, but we shall, nevertheless, be successful in sketching in broad features a faithful picture of a portion of the original history of the wireless system mentioned above. The following is information which we have obtained from various sources:

When in the beginning of 1917 Dr. C. J. de Groot took his doctorate at the High School of Delft he stated in a paper the view that a direct wireless communication between the Dutch Indies and the Netherlands was to be regarded as a possiblity. But there were few people who gave credence to that view. At that moment radiotelegraphy was not so far advanced as now and when people in Europe heard of the wireless station of German East Africa it was regarded as a fact of quite special importance.

Then it was that Herr Le Roy, the Director of the German Asiatic Telegraph Company, regarded it desirable to place himself in relation with Dr. de Groot and for this purpose he made a journey from Keulen, his headquarters, to the Hague for the purpose of making enquiries regarding the plans of our Engineer.

Firmly convinced that Germany would win the war, Herr Le Roy gave Dr. de Groot the advice, which, however, almost amounted to a command, to remain "in the German Line" (i.e., within the German sphere of action) in everything that he might undertake. It was from that moment that Herr Le Roy meddled with out wireless, very much to the disadvantage of the rapid realisation of this communication.

This gentleman's aim was to supplant the English cable monopoly by a hegemony of the Telefunken over our aerial system, which was certainly not in accordance with our intentions since we were striving for independence.

Herr de Groot proceeded to the Dutch Indies and immediately commenced activities, which in those days led to a very brilliant result. Through the Minister of the Colonies a sending apparatus was ordered in America which was installed at Malabar as early as November, 1917, and with which good results were obtained from the very first.

Herr Le Roy, however, did not relinquish his operations, and offered, in the name of the Telefunken Company, gratis, a time-sending apparatus destined for the Dutch Indies. It was well understood that Holland would be compelled to pay "through the nose" later on for this apparent gift.

The Telefunken apparatus arrived in the Indies by the warship "Zeeland" and the Governor did not feel wholly charmed with this little gift which was being fastened about our necks and by which an effort was being made to compete with Dr. de Groot. The latter should be afforded a good opportunity to succeed in his great enterprise and the Governor General is to be greatly praised for having allowed the installation to lie dormant for eight months at Soerabaja. It might perhaps have been there yet had not tele-

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graphic instructions been received from Holland insisting upon the installation of the (German) apparatus, failing which Germany threatened to stop the export of coal to Holland. The apparatus therefore received a place near the district capital of Tjililin, south west of Bandoen and received the necessary electric current from the B.E.M. from Dago, whence it was conveyed by high tension cable. The wireless at Malabar originally received its current from the same source, but it now has its own source of power, so that the sweeping away of the transformer house owing to the earthquake at Dago, did not affect it adversely.

There is still more mystery surrounding the radio station on Tjililin than that of Malabar. In the beginning we were only able to learn that Herr Moens, the Telefunken Agent, obtained control over a tractor of the military auto-service by which he was able to secure the transport of heavy cases which were addressed to Dr. de Groot, to the station of Tjililin, regarding which we have already written a short article. The new installation came under the supervision of Dr. de Groot, who as representative of the Government, had to exercise surveillance over his competitor.

German influence was, however, able to accomplish still more, and to this day has prevented the installation of a re ceiving station (i.e., in Holland) since it was argued that the Indies could signal their messages to Nauen.

Meanwhile there arrived in Holland as supporter to Dr. de Groot, Herr Dubois, who was not able to achieve much, but owing to his intervention he managed that the question should be examined somewhat more closely. Notwithstanding this Telefunken carried the day and a definite installation was sent by a convoy, which, however, was discovered by the English and had to be unloaded. Then it was that the convoy had to return—officially it was stated that a consignment of paint of German manufacture had to be unloaded. The Minister, however, judged it necessary, in order not to spoil Telefunken's chances, to report that a Dutch wireless set, against the transit of which no objection could be raised, had had to be unloaded.

Now work is proceeding actively for the completion of both stations. Malabar is being made much more powerful and will reach 2,400 kilowatts, whilst the best French stations only use 1,500 kilowatts. Telefunken, however, is against this, and is only willing to go to 400. Luckily one is not holding entirely to that system since if it does not fulfill the demands made upon it, the contract will be broken. It will, however, probably be removed to Malabar, and on behalf of the Telefunken Company a power station is being built at Dajeub-Kolot, on the Tjitaroem, the building of which alone will cost the fabulous sum of three hundred thousand guilders.

* * *

WIRELESS TELEPHONES ON JAPANESE LINERS.

Tokio papers state that wireless telephones are to be installed on the Toyo Kisen Kaisha passenger liners trading across the Pacific from San Francisco to Yokohama. Arrangements are also being made to connect up these steamers, when at sea, with the public telephone exchanges at Tokyo and Yokohama via the wireless apparatus. Ocean passengers will thus be able to speak direct to their friends at home.

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A Competition for Commercial Wireless Operators

MANY of the problems of radio communication depend for their solution upon data collected by competent observers in all parts of the world. Given a mass of reliable information the scientist can attack it, trace laws or departure from laws, and probably arrive at a satisfactory hypothesis, but if he cannot travel widely, if he has at his disposal only facts relating to the particular part of the world in which he lives, he is badly handicapped. Before Darwin produced his epoch-making *Origin of Species* he spent twenty years in gathering data from naturalists, breeders, horticulturists and hunters in almost every country under the sun.

On page 331 of this issue there begins an article written by Dr. W. H. Eccles, who is well-known to most radio workers, in which he describes how wireless operators may render valuable assistance to those who make it their business to study the unsolved puzzles connected with wireless. The article has been written specially for the purpose of our competition and is intended as a guide to competitors as to the line of work to take up. The rest of the article will appear in our October number which will be published on September 25th. After having read the whole article make up your mind what work you can best perform and submit your results in the most suitable form, that is, as article, chart, schedule, curve, or list, or a combination of these.

(1) On the front cover of the September and October numbers will be found a coupon bearing the words, "W.W. Competition," and the name of the month. These coupons must be fastened to a covering letter containing the name and address of competitor, name of wireless station he is employed on, and the name of his employer; this letter must accompany the work sent in.

(2) Results are to be sent in an envelope or cover, marked "Competition," to the Editor, WIRELESS WORLD, 12-13 Henrietta Street, Strand, London, W.C.2.

(3) All manuscripts must be sent to the above address so as to reach it not later than January 7th, 1920.

(4) Manuscripts must be plainly written, one side only of the paper being used.

(5) No correspondence, either before or after the publication of the winners' names, can be entered upon.

(6) First prize, twelve guineas; second prize, six guineas; four consolation prizes, each consisting of Dr. Fleming's new book, entitled *The Thermionic Valve and Its Developments in Radiotelegraphy and Telephony*, and Mr. Philip R. Coursey's *Telephony without Wires*.

(7) The selection of the prize-winners will be made by Dr. J. Erskine-Murray and the Joint Editors of the WIRELESS WORLD, and the names of the successful competitors will be published in the WIRELESS WORLD for March, 1920.

(8) The decision of the editors shall be final.

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Wireless Telegraphy Problems for Operators

By W. H. Eccles, D.Sc.

This article has been specially written by Dr. Eccles for the purpose of showing intending competitors (see Competition described on p. 330) the fields which are open to them for research. The article is intended to be suggestive only, and competitors need not consider themselves necessarily bound to work on the lines indicated.

BEFORE the war the British Association Committee for Radiotelegraphic Investigation had started a scheme of investigations of a kind that could be carried out by operators and amateurs, and had collected a great deal of information. Most of this was greatly affected by seasonal changes and many of the phenomena observed probably vary from year to year. But the scheme had not been in operation a full twelve months at the time the war broke out and stopped it. Consequently a great deal of the potential value of the work already done was lost. It is in the power of operators to resume a number of these investigations, though it is not yet certain that the B/A. Committee will again embark upon so comprehensive a scheme. The public-spirited enterprise now being initiated by THE WIRELESS WORLD promises to stimulate the prosecution of similar researches and to inaugurate others of a kind not possible to amateurs even if the amateur were at present free to begin work again. The professional operator is, apart from his opportunities for developing personal skill in the use of his apparatus, in a position of great advantage over the amateur in the respect that his station and his wireless gear form a very distinct, constant and full-size unit, such as few amateurs can hope to possess. Besides this, the station of the sea-going operator moves about, and therefore affords excellent opportunities for the measurement of the variation of the strength of signals with distance and similar investigations usually beyond the reach of the amateur.

In attempting to give an outline of the experiments and investigations possible to the sea-going operator, it is necessary to fulfil the conditions that these shall not interfere with his traffic duties or involve derangements of his apparatus. Even with these limitations a great deal of most useful work can be done. In this article I need only refer to two classes of investigation, one directed to the study of the influence of natural phenomena on the propagation of signal waves, the other class dealing with the disturbances called variously "strays," "static," "atmospherics," or "X's."

Influence of Natural Phenomena on the Propagation of Signal Waves.

Problems under this heading will usually be studied by observations on the variation of the strength of signals transmitted from some regularly-working station running under reasonably constant conditions. For example, time signals and press messages from the various high-power stations can be observed

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regularly at fixed stations, and the effects of the phenomena mentioned below studied as regards their influence on the propagation of the waves. The sea-going operator, by similar observations, can hope to contribute to the establishment of the laws connecting distance and strength of signal from the same transmitting station. The natural phenomena principally concerned fall into two groups, one concerned with atmospheric action, the other with physical geography.

Variations due to Atmospheric Actions.

The most prominent of these are those due to the daily journey of the sun across the sky and, to a less extent, to the motion of the moon. The influence of the sun is enormous; the range of a station is far greater by night than by day and every sunrise and sunset brings about very striking phenomena. The atmosphere seems to be less transparent in the day than in the night and seems to be very opaque on occasion in the twilight band. Wireless experience taken alone suggests that ultra-violet or similar "ionising rays" from the sun give the air the property of absorbing the signal waves or of deflecting them; and from what is known of the action of such rays on rarefied gas, it seems likely that the layers of the atmosphere between 10 and 40 miles high are involved. At sunset these layers of the air begin to lose their property but other higher layers, apparently at a height of about 40 miles remain possessed of the deflecting powers and appear to act beneficially as reflectors of the wireless waves. Continuous observations of the times near sunset and sunrise when the change from day to night conditions takes place could not fail to be of help in the understanding of these facts.

Besides these regular variations there are the variations known as "fading." The cause of this is quite unknown and is not likely to be discovered except by careful observing and recording of the facts. Probably the records obtained this way would have to be compared with the records of magnetic observatories, for the regular diurnal variations of the earth's magnetic field seem to be closely connected with the electrical conductivity of the layers of the atmosphere less than 50 miles above the earth.

There is evidence that the atmosphere at even less than 10 miles from the earth has its effect on signals. Clouds and moisture may have an influence and great storms such as tornadoes and cyclones certainly do. But it is very uncertain, still, whether the layers above 60 miles high come into play in wireless signalling either during the day or the night. The best way of settling this point is to observe, whenever possible, any effects apparently exerted by auroral displays. The aurora is never below about 60 miles, and as it is an electrical phenomenon, it may be expected to exert some influence on electric waves if indeed they go so high. Those observers who have the opportunity should therefore observe both long and short distance signals when an auroral display is in progress—perhaps in this way it might be settled whether waves from a far distant station travel to greater heights than waves from a relatively near station. In passing, it may be noted that all the great magnetic storms are associated with auroral displays, and the navigating officer on a ship usually knows when a magnetic storm is in progress. Such storms may last more than a whole day. They produce great disturbances in submarine and land lines, but no one has yet detected any influence on wireless.

(To be continued.)

(The concluding portion of this article will be published in our October number on Sept. 25th. Competitors will thus have approximately three months in which to prepare their papers.)

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Notes of the Month

AIRCRAFT EXHIBITION AT AMSTERDAM.

Through the enterprise of the Dutch Government an Aircraft Exhibition was opened at Amsterdam on August 1st, at which most of the leading British Aircraft Manufacturing Firms are exhibiting. Marconi's Wireless Telegraph Company, Ltd., show their standard Transmitting, Receiving and Direction-Finding Sets for Aircraft, as well as a certain amount of Field Station Apparatus. The most interesting feature of the Marconi Company's Aircraft exhibits is the new 100-watt Aircraft Telephone Transmitter. This set has a range from air to ground of from 80 to 100 miles, using 70 feet masts and a standard three-valve receiver on the ground. The Direction-Finding Apparatus displayed is of a similar type to that supplied to the transatlantic Handley-Page machine which gave such successful results on the voyage of that machine from Newfoundland to Nova Scotia. In addition to the apparatus shown on the Stand there is a standard Telephone Ground Transmitting Station in the Exhibition Grounds, and arrangements have been made for practical demonstrations of both the Direction-Finding and Telephony Sets for air to ground and ground to air communication. This means that passengers taking trial flights will be able to talk with their friends on the ground, and *vice versa.*

* * *

REMOVAL OF CENSORSHIP.

The censorship was abolished, so far as British controlled cables and wireless telegraphs are concerned, from midnight on July 23rd-24th. Telegrams will now be accepted without restriction to all British possessions, to the United States and Possessions, and generally to all parts of the world, with the exception of the following countries in which restrictions have not yet been abrogated by the authorities concerned:

Germany, Austria, Hungary, Bulgaria and Turkey (including Palestine, Syria and Mesopotamia), France and French Possesions, Greece, Roumania, and Kingdom of Serbs, Croats and Slovenes, Czecho-Slovakia and Poland, Finland, Esthonia, Lithuania, Russia (including Caucasus and Russia in Asia), Norway, Sweden and Switzerland, Japan, Honduras, Argentina.

The Postmaster-General is in communication with the Administrations of these countries, and a further announcement will be made when the existing restrictions on telegraphic correspondence with any of them are abolished.

* * *

MARCONI'S WIRELESS TELEGRAPH CO., LTD., *v.* THE POSTMASTER-GENERAL.

On July 25th, Mr. Justice A. T. Lawrence delivered his award in the arbitration proceedings between the above-mentioned parties. In awarding the Marconi Company £590,000, he said, " I only want to say with regard to it that that is my estimate of the present worth of all the royalties the Company would have recovered under the contract. I have excluded from consideration, as by order directed, the letter of January 1st, 1915, and I have not diminished the amount by any con-

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sideration of the probability or otherwise of Marconi patents being employed in commercial wireless in the future."

* * *

THE MARCONI WIRELESS TELEGRAPH CO. OF AMERICA, *v.* THE ATLANTIC COMMUNICATION CO.

Judgment has been obtained by the first-mentioned firm in its action, the subject of which was the use of the audion, which was held to infringe the Marconi Co's. Fleming patent of Nov. 5th, 1905. The Atlantic Communication Co. before the war operated the notorious station at Sayville.

* * *

THE NEW WIRELESS TELEGRAPHY BILL.

Lord Somerleyton's Merchant Shipping (Wireless Telegraphy) Bill, which requires every passenger and cargo steamer of 1,600 tons and upwards to be equipped with wireless telegraphic-apparatus, has passed the third reading.

* * *

WIRELESS CLUB NOTES.

The Wireless and Experimental Association.

The Amateur Wireless Alliance, late of Peckham Rye, S.E., has been reorganised under the name of the Wireless and Experimental Association, with headquarters at 16, Peckham Road, Camberwell, S.E.

Mr. F. H. Gribble, 48, Surrey Square, Walworth, S.E., has been appointed Secretary, and will be glad to see any visitors at the Club's headquarters any Wednesday evening at 7 o'clock.

A strong committee has been drawn together, and London readers will no doubt find many of their old wireless and experimental friends attached to this new Association.

Three Towns Wireless Club.

July 3rd.

A Morse practice was followed by a general discussion. A member suggested an exhibition of home-made apparatus, and this will probably be arranged soon. A feature of the evening was the reading of some translations from an American Amateur Wireless Journal.

July 9th.

The Club met at the Plymouth Chambers. Mr. J. Jerritt presided. Mr. Lock, one of the members, gave an instructive lecture dealing with inductance, capacity, and tuning as applied to Wireless Telegraphy.

July 17th.

Mr. Jerritt presided. Mr. Voss lectured on the "Difficulties likely to be encountered by Amateur Wireless Men," dealing more especially with receiving circuits and their construction, also the difficulties encountered in erecting efficient aerials in a small space.

July 24th.

Mr. Jerritt presided. Mr. Lock gave a most interesting lecture on "My First Wireless Apparatus," starting on the coheter and bell, and working up to his pre-war instruments. Some interesting sketches of his proposed C.W. set were shown and explained.

The Club will be pleased to welcome visitors and to enrol new members. All communications should be sent to W. Rose, Hon. Sec., 7 Brandreth Road, Compton, Plymouth.

* * *

North Middlesex Wireless Club.

The 21st meeting of the Club was held at Shaftesbury Hall, Bowes Park, on July 15th. In spite of a number of the members being on holiday there was a very fair attendance, and the meeting was quite a success.

The first part of the evening was devoted to the business of electing the Officers of the Club for the year. The

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President, Mr. A. G. Arthur, and the Hon. Secretary, Mr. E. M. Savage, in accordance with the rules of the Club, retired automatically at the end of their year of office, and were eligible for re-election.

Mr. Arthur was then again proposed as President by Mr. Midworth and seconded by Mr. Green, and there being no other member proposed for this office Mr. Arthur was duly elected.

Mr. Savage was again elected as Secretary, and Messrs. A. W. Hulbert, L. C. Holton, and W. Gartland offered themselves to serve on the Committee, and were duly appointed.

The President, in the course of his remarks, which by their dry humour are always keenly appreciated by the members present, drew attention to the fact that the Wireless Officer on board H.M. Airship R.34, Lieut. R. F. Durrant, was a member of the Club, and up to the outbreak of War had served on the Committee and had always been a live member. Before joining the forces his work was in no way connected with Wireless or Electricity, but the knowledge gained in pursuit of his hobby had enabled him to take responsible positions in the Wireless Service. Mr. Arthur said that he was sure the members would feel proud that a member of the North Middlesex Wireless Club was numbered among the officers of the R.34.

Particulars of the Club may be had from the Hon. Secretary, Mr. E. M. Savage, "Nithsdale," Eversley Park Road, Winchmore Hill, N.

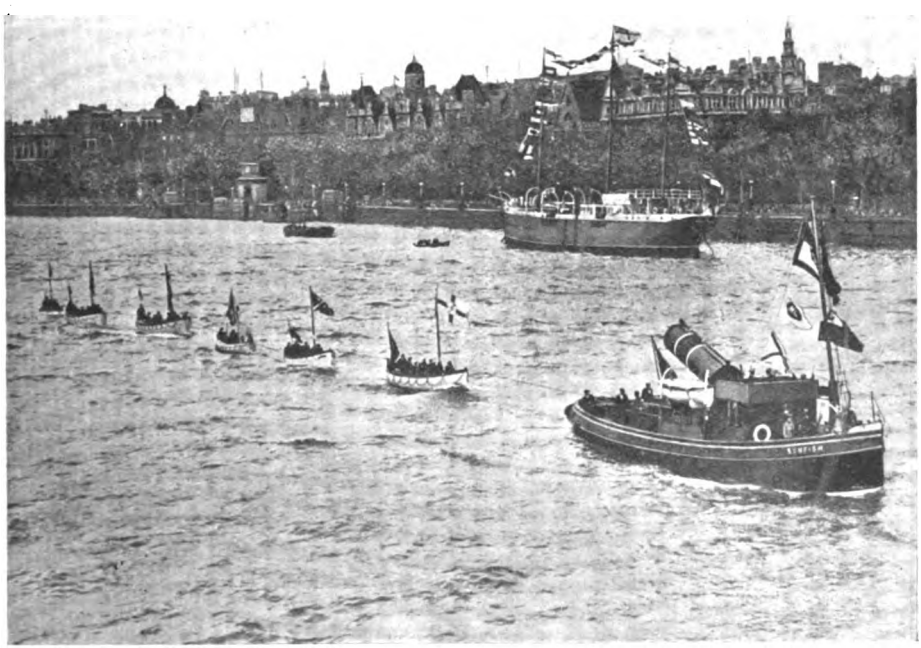

Photo by Herbert F. Baldwin.

Mercantile Wireless Telegraphists in the Thames Pageant, August 4th, 1919, Their boat is the one immediately behind the Tug.

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The Victory March

WHEN, on July 19th, a representative body of the Empire's forces marched through London in celebration of peace and victory, twelve wireless operators of the Mercantile Marine took a well-merited part in the procession. These men and their colleagues shared equally with seamen the risks of keeping the seas, and in very many cases paid with life and limb the price of duty faithfully done. Even after repeated torpedoings they did not hesitate to go yet again into the danger zones strewn with mines or infested by German submarines, and what the Empire owes to them can be neither calculated nor paid for. We have much pleasure in reproducing a photograph of nine of the gentlemen who took part in the march.

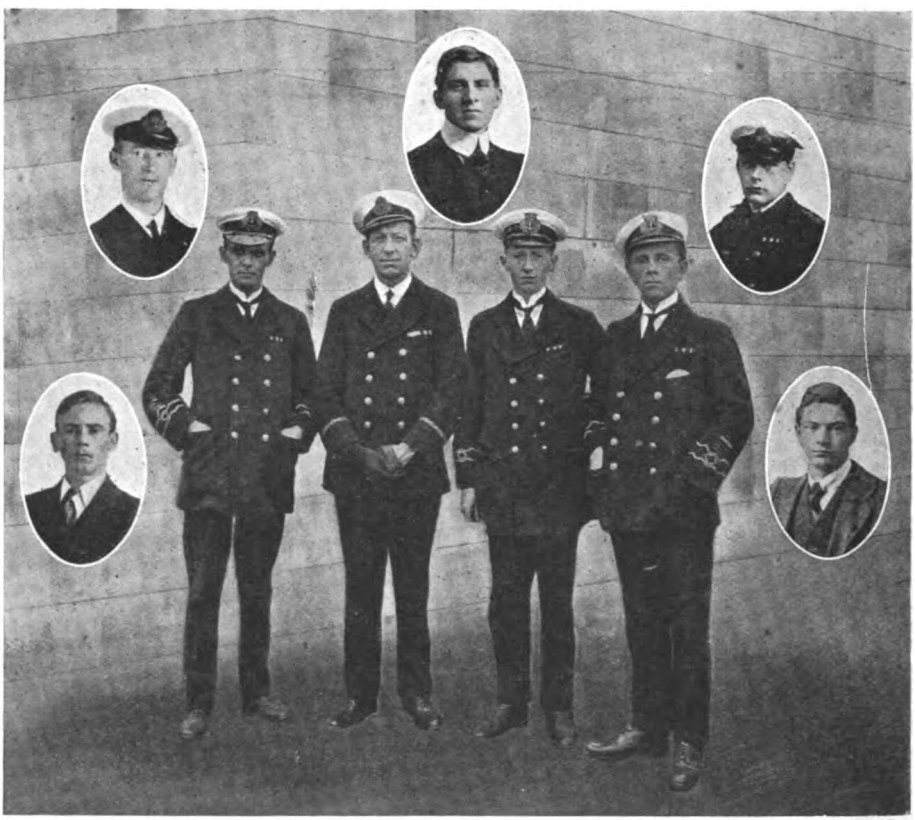

Photo by Topical Press.

Standing (left to right)—S. A. SORRELL, E. A. WATKINSON, M. FRAWLEY, C. H. DURRANT.
Inset (top)—W. S. SUTHERLAND, H. STURDY, H. E. MULLEY.
Inset (bottom)—F. J. H. BLIGH, A. DINSDALE.

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The Theory of Valve Rectification

By W. S. Barrell.

(Continued from August Number.)

GRID CURRENTS.

IN our study of the elementary principles governing rectification by the three-electrode valve, we have, up to the present, only considered one class of curve, namely, that produced by plotting the current in the anode circuit against grid voltage. So far we have been chiefly concerned with the anode current, any currents which might flow in the grid-filament circuit having been neglected.

It will now be necessary to consider the phenomena taking place in the latter circuit, for, as will be shown, under certain conditions currents will flow which have an important bearing on rectification. Whether the current in the grid circuit flows continually in one direction or whether after a time it changes in direction will depend upon certain points which will be discussed later.

The first point for consideration is, what is the effect, if any, on the grid current when the potential of the grid is varied, and this can most easily be studied from a curve in which grid current is plotted against grid voltage.

A circuit should be set up as shown in Fig. 10, which is essentially the same as that utilized for obtaining the grid voltage-anode current characteristic, but with the addition of a micro-ammeter Ma inserted in the grid-filament circuit. Using the scheme of connections shown in the diagram it becomes quite easy to take the readings for the grid current and anode current curves simultaneously should both be required.

It was mentioned above that under certain conditions the grid current might change in direction, and therefore it is preferable that the zero position of the micro-ammeter needle be adjusted to somewhere near the centre of the scale.

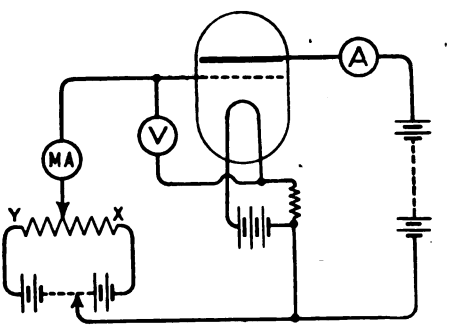

Fig. 10.

This condition will cover the case of all valves whether hard or soft, but at the moment, we shall continue to deal with hard valves only, and for these it is not so necessary that this adjustment be made as all the readings will be in one direction. The advantage of the central zero will be shown when dealing with soft tubes.

Referring to Fig. 10, the voltmeter, V, will indicate the potential of the grid with respect to the negative end of the filament and, as this may be either negative or positive, an instrument with a central zero is advocated. The ordinary voltmeter could of course be used, but then the leads would have to be reversed when changing from negative to positive values and vice versa. The anode current is measured by the instrument A, and the readings of Ma will show the current and its direction in the grid circuit. Commencing then with the potentiometer slider at X, readings of all instruments should be taken at, say, every half volt (as recommended when

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taking the Fleming Valve curve*) until the slider is at Y.

Three sets of figures will thus be obtained: (1) Values of grid voltages; (2) Anode current; (3) Grid current, and the curves may be plotted as shown in Fig. 11, A and A_1. As the grid currents are so much smaller than the anode currents the curve A_1 has been drawn to a larger scale.

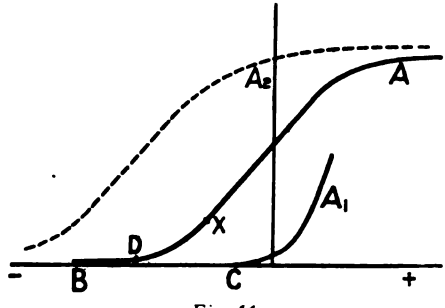

Fig. 11.

A study of these curves will reveal several interesting facts. First of all, it will be noticed that the anode current commences much earlier than the grid current, and in fact reaches a comparatively high value before a current starts in the grid circuit. Secondly, it will be seen that from B to C a current is flowing in the anode circuit, but not in the grid circuit. Thirdly, the grid current curve has a sharp bend somewhat similar to the bend in the anode current curve. The dotted curve A_2 has been added to show the effect of increasing the anode voltage. The curve is seen to be raised vertically, but it should be noted that the grid current curve is practically unaffected by the increase in anode voltage.

GRID CURRENT AS AN AID TO RECTIFICATION.

The method of using the valve as a rectifier working at the bend of the anode characteristic, D Fig 11, has already been considered and it is now supposed that the grid potential is increased so that normally the valve is working at the point X Fig. 11. The slope of the curve at this point is much greater than at the point D, and therefore it follows that any given voltage variation on the grid will now give a greater variation in anode current. It is to be noticed, however, that we are now working on the straight part of the curve, and at first sight it would appear that, from the effect of an incoming oscillation, the increase in anode current due to the positive half waves would be exactly equal to the decrease due to the negative half waves. It follows that under these conditions the normal current through the telephones would remain unaltered, and no signal would be heard. A further reference to Fig. 11 shows that normally the grid potential is at such a value that the grid current is zero. The negative half waves will reduce the potential of the grid and consequently the current in the anode circuit, but the positive half waves will increase the grid potential to the point at which a current flows in the grid circuit. Let us consider this action a little more closely. The circuit is shown in Fig. 9* from which it is seen that the oscillatory circuit is shunted by the grid and filament circuit of the valve. When the grid assumes its normal potential no current flows in this circuit and the resistance of the shunt is infinite. When a current flows in the grid circuit, however, the resistance of this shunt falls and since the damping of the oscillatory circuit depends largely upon the value of the shunted resistance, the latter may fall sufficiently low to damp out the positive half waves. In this way the variations in the anode current will not be equal on both sides of the point X, and in fact will be much greater for the negative half waves. As

* WIRELESS WORLD, July, 1919, p. 182.

* WIRELESS WORLD, August, 1919, p. 246.

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the effect of these is to decrease the anode current the mean value will be reduced, and consequently a signal will be heard in a telephone connected in the anode circuit. We may thus look upon the oscillatory circuit as being shunted by a variable resistance (the value) which varies from infinity to a comparatively low value.

CUMULATIVE RECTIFICATION.

The circuit shown in Fig. 12 will now be considered and should be compared with that shown in Fig. 9*. It will be noticed that the grid potentiometer has been omitted, the lead from the lower end of the oscillatory circuit being connected direct to the positive end of the filament battery. Further,

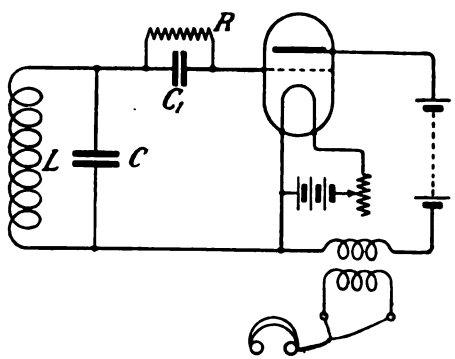

Fig. 12.

in the lead to the grid a small condenser C_1 has been inserted which is shunted by a high resistance R. Suppose this circuit to be coupled to a suitable aerial system. An incoming wave train will produce oscillations in the circuit LC which are rectified between the filament and grid of the valve. The rectified current will charge up the condenser C_1, the side connected to the grid receiving the negative charge. This will be readily understood, remembering that electrons are minute negative charges. The negative charge thus produced on the grid decreases the flow of electrons to the anode. In consequence a reduction of current in the telephones connected in the anode circuit takes place and a signal is heard.

It has been shown that the effect of a wave train is to impart a powerful negative charge to the grid, and before the valve is in a condition to detect any subsequent wave train this negative charge must be neutralized, thus allowing the potential of the grid and consequently the anode current to resume their normal values.

In hard tubes such as we are considering there is so little gas present that the charge cannot leak off through the tube and the necessity of the grid leak becomes apparent. When the oscillations cease a current from the filament battery flows through the resistance R, neutralizing the charge on the grid. The valve re-assumes its normal state and is then ready to detect the next wave train. The cumulative effect of a wave train causes a signal in the telephones by decreasing the anode current which, by the action explained, rises to its normal value at the end of the train.

As soft valves are now but little used only a very brief explanation of some of the more important phenomena will be given.

In Fig. 13 is shown the grid current curve of a soft valve. Comparing this with curve A_1 Fig. 11, a very striking difference will be noticed. In the case of the hard tube the curve is entirely above the horizontal axis, but in the case of Fig. 13 it will be seen that part is below. In the latter case the microammeter Ma (Fig. 10) first gave a deflection in one direction which increased up to the point A. It then decreased to the point B where it changed sign. That part of the curve above the axis of V denotes a current from the filament

* WIRELESS WORLD, August, 1919, p. 246.

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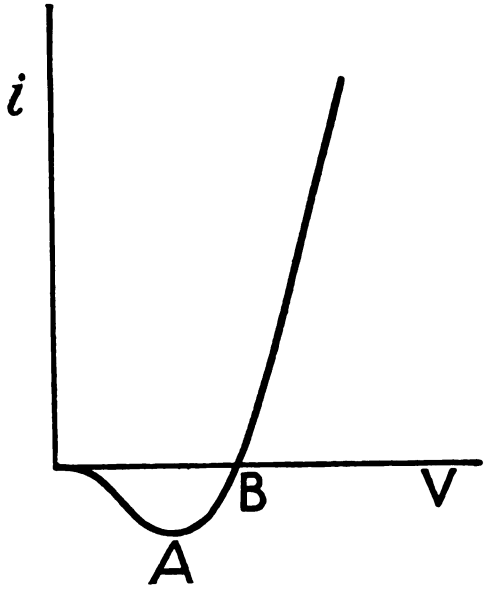

Fig 13.

to the grid, and that below the V axis is a measure of the current flowing from the grid to the filament. The fact then that the curve in Fig 13 is partly below the horizontal axis shows that for potentials up to B the grid receives more positive than negative electricity through the valve. This can be shown as follows: When studying the phenomena of hard valves the moving electrons only had to be considered, but in tubes containing gas the effect of the positive ions has to be considered in addition to the electrons. By reason of the anode potential the electrons will travel at the highest speed in the space between the grid and the anode. The valve being soft, the swiftly moving electrons will ionize the gas, that is, will split up the molecules by collision into positive ions and electrons. Due to the attraction between unlike charges, the positive ions will move towards the filament, the newly formed electrons joining the original electron stream to the anode. Some of the positive ions will, however, be intercepted by the grid which may therefore receive more positive than negative electricity as shown by the curve, Fig. 13.

For a given high tension anode voltage the softer the tube, i.e., the greater the number of gas molecules, the greater will be the dip below the axis of V. It can further be shown that provided the pressure of gas be constant the position of the bend in the curve depends upon the nlament temperature and the potential of the anode.

If the anode potential is too high for the valve the positive ions will entirely neutralize the space charge; the electron flow to the anode will be very heavy and a violent blue glow seen in the tube. In this condition the valve is very insensitive as the control by small voltage changes on the grid is lost.

WIRELESS AND THE INTERNATIONAL COMMISSION FOR AIR NAVIGATION.

The following is an extract from the regulations framed by the International Commission for Air Navigation:—

Wireless apparatus must not be carried without a special license issued by the State whose nationality the aircraft possesses, but every aircraft used in public transport and capable of carrying ten or more persons shall be equipped with sending and receiving wireless apparatus when the methods of employing such apparatus shall have been determined by the International Commission for Air Navigation.

The Commission may later extend the obligation of carrying wireless apparatus to all other classes of aircraft.

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Aircraft Wireless Section

Edited by J. J. Honan (late Lieutenant and Instructor, R.A.F.).

These articles are intended primarily to offer, as simply as possible, some useful information to those to whom wireless sets are but auxiliary "gadgets" in a wider sphere of activity. It is hoped, however, that they may also prove of interest to the wireless worker generally, as illustrating types of instruments that have been specially evolved to meet the specific needs of the Aviator.

AIRCRAFT WIRELESS SETS.

THE No. 1 TRANSMITTER— (Continued).

Fittings and Accessories.

THE FAIRLEAD.

This consists of a metal tube (Fig. 15) with an insulated top portion fitted into the floor of the nacelle and forming a guideway for the aerial wire coming from the winch or reel. The aerial on leaving the fairlead swings backwards owing to the velocity of the plane, and takes for some distance a path roughly parallel to that of the bus, being thereby forced into good electrical contact with the metal tube of the fairlead. The aerial lead from the set is connected by a screw to a flanged part on the top of the tube, as shown, thus forming the equivalent of the "lead in" on a ground set. It is a good plan to protect the top of the fairlead by a wooden or rubber block or shield, so as to save it from damage by the feet of the pilot or operator.

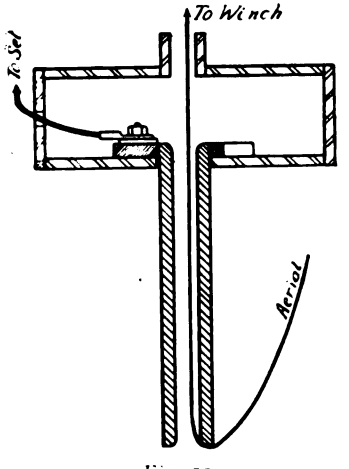

Fig. 15.

EARTHING.

The earth lead from the set should be connected to as much of the metal work of the bus as possible. These parts constitute the capacity earth of the system, and the larger this can be made the more favourable will be the "form factor" of the aerial circuit. A good earth is obtained by running a couple of copper strips along the longerons and "bonding" all metallic parts. In addition to giving the maximum capacity, this arrangement considerably reduces resistance losses in the earth circuit, and increases radiation efficiency.

AERIAL WINCH OR REEL.

This is usually fitted on the left-hand side of the operator, at a suitable height for convenient manipulation. It is a simple matter to let the aerial down, but winding it in is somewhat more

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fatiguing, particularly if the operator is forced into a cramped position whilst doing so. Consideration given to this point will save much heat and ill-temper in the air.

The reel is fitted with a spring band brake which in the normal position holds it against rotation. The fixed end of the aerial is secured to the drum of the reel by a short piece of cord or gut.

DROPPING THE AERIAL.

In letting the aerial out it is sufficient to free the band brake by pushing in the spring-pressed spindle until it drops into a catch which holds the spring in compression and leaves the reel free to rotate.

The weight of the plummet then causes the aerial to unwind. It is advisable to brake the reel slightly with the hand in order to avoid too rapid a descent, as, if the plummet is allowed to drop quite freely, it will probably snap the cord by which the end of the aerial wire is fastened to the drum of the reel, in which case the role of the wireless gear will become purely ornamental so far as that particular trip is concerned.

WINDING-IN.

Winding-in should be done as steadily as possible. The plummet will sway and jerk considerably as it comes in, particularly towards the end of the operation, and if it is subjected to extra strain by a too energetic operation of the reel handle will probably part company with the aerial, more especially if it is brought home with a nasty jar against the fairlead or guide. As it is of lead and weighs two or three pounds, the mishap is one which does not add anything to the popularity of the airman, particularly when it occurs over a crowded landscape.

A piece of thick rubber tubing fitted over the part where the plummet is spliced or fastened to the aerial serves to buffer the final shock as the plummet comes home, and is a safeguard well worth utilizing.

RE-WINDING AFTER USE.

It is difficult in winding-in to ensure that the layers of wire are laid evenly and regularly on to the drum of the reel. Unless this is done, it is not safe to drop the aerial, as previously described, on the next flight, as in the rapid descent the wire would probably tangle and get jammed. It should therefore be a standing rule to have the aerial unwound after each trip and carefully and neatly re-wound on the ground ready for the next ascent.

THE HANGING AERIAL.

Altogether the hanging aerial is a messy and inconvenient arrangement, but unfortunately there is, as yet, no practical alternative for transmitting purposes.

It is otherwise in the case of reception, where the use of the loop aerial is becoming general.

SUMMARY.

In a general overhaul of the wireless installation of a bus, the following points are worth attention:—

See that the Fairlead is clean and not choked up with mud from the boots of the last operator. Also see that the bottom edge is not too grooved by the aerial wire to cause possible sticking or jamming in the notch.

Examine the band-brake spring on the winch, and see that the brake has sufficient grip and has not worn loose.

Look at the gut or cord fastening the aerial to the winch, and see that it is not frayed or liable to give should the

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aerial be "inadvertently" let out with a run.

See that the plummet is securely spliced or secured to the end of the aerial.

Take care that the aerial has been rewound on the ground after the last flight, so that the coils lie neatly around the axle of the drum, ready to come off smoothly when the aerial is dropped in the air.

Take a general look at the wiring with particular attention to the earthing, safety plug, and key contacts (also signal lamp contacts, if used).

Test accumulators on load, and see that they are not placed in a position where the terminals may possibly be short-circuited by contact with metallic parts of the bus.

In runing over the transmitters, see that all terminals and connections are O.K.; test the make and break—see that it is not "sticking." Try spark-gap adjustment. See that locking screws for gap and break are tight. Examine helix clips. See that closed circuit is correctly adjusted if working on given wavelength. Make sure that aerial is of proper length or is properly marked in accordance with previous calibrations of wavelengths for the bus in question, and that the operator knows what coupling to use with the given wavelength.

If after all this the wireless set goes wrong in the air, the first step should be to disintegrate it with a coal hammer, and the next to seek some other more interesting vocation in life.

(To be continued.)

TESTS OF X-STOPPING DEVICES.

A PAPER by Major G. O. Squier communicated to the Franklin Institute describes an investigation of various arrangements for improving reception through atmospheric interference. The chief conclusions arrived at from these tests may be summarised briefly as follows:—Tests carried out with frame aerials showed conclusively that they did not possess any advantage over the horizontal aerials, the ratio of signal strength to X-strength not being improved, while at times the signals on the frame aerials were prohibitively weak. Both audio and radio balancing between two frame aerials at right angles were tried, but without success. Simultaneous photographic records of X-impulses received on two loops at right angles to one another showed that the extraneous disturbances did not occur simultaneously in two mutually perpendicular planes. A screened horizontal aerial was also tested, the screen consisted of loops of copper wire spaced at equal distances along the horizontal aerial, connected together by high resistance wires and earthed at several points. Repeated tests showed that this screening system possessed no advantages.

Enclosing the horizontal aerial in a covering of insulating material of low specific inductive capacity likewise showed no improvement. The signal strength obtained on an aerial composed of copper wire netting showed no improvement in the ratio of signal strength to X-strength, as compared with horizontal aerials while at the same time the signal strength on the wire netting aerial was very low.

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Aviation Notes.

R.34 WIRELESS.

THE responsible wireless personnel of the Royal Air Force is to be congratulated upon the excellent results obtained during the R.34's transatlantic trip. It is no exaggeration to say that all previous records of wireless work in the air have been surpassed. In addition most valuable experience has been gained which will bear fruit in good time for the betterment and advance of aero-radiology generally.

The airship carried two transmitters. One a C.W. valve set (Service type 15) for long-range work, and the other a Marconi Spark set. The former worked on a normal wavelength of 1,400 metres, the latter on 600 metres.

A telephony set, and a radiogoniometer installation for direction-finding in the air were also aboard.

The receiver, in particular the small Service type T.f., gave some remarkably efficient results.

Some of the distances covered both in receiving and transmitting are set out in the accompanying chart which gives a more illuminating illustration of the work done than could be set out in umpteen weary words.

It is a most encouraging record and is well worth a careful examination by those of our readers who are interested in the aviation field of wireless achievement.

The following is extracted from an official announcement by the Air Ministry on the work done during the outward voyage.

The Royal Air Force Station at Dundee exchanged signals at 1,000 miles. The R.34 sent messages that were read by the Air Ministry at 1,100 miles, by Wormwood Scrubbs at 1,135 miles and by Ballybunion at 1,600 miles. In one case, when the airship was approaching America, a signal was sent to her from the Air Ministry through the Marconi Station at Clifden, and a reply was received *via* St. John's, Glace Bay, Clifden and Marconi House, and thence to the Air Ministry all in twenty minutes!

The credit of being the first R.A.F. Wireless Station to "pick up" the R.34 on her return trip belongs to the Mullion Station, which received signals from R.34 a few minutes before this was accomplished by East Fortune and the Air Ministry Station.

This information was not available until too late to include it in the chart.

An Appreciation.

The following letter of thanks, addressed by the Air Ministry to the Management of the Marconi Wireless Telegraph Company, is published apropos of our remarks last month regarding the amount of wireless work involved in collecting the necessary meteorological data, and in otherwise contributing towards the success of the recent transatlantic flights:

> "I am commanded by the Air Council to express their thanks for the valuable assistance your company rendered in connection with the recent. transatlantic Flights by H.M. Airship R.34. The generous and liberal use of your high-power stations, Clifden and Glace Bay, together with the work undertaken spontaneously by Cape Race Station, contributed largely to the success of these flights, and the Air Council greatly appreciates the wholehearted manner in which your company put its entire and elaborate organization

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at the disposal of the Air Ministry. "The promptitude, too, with which all traffic undertaken by your Company, in this connection, was dealt with was most creditable."

I am, sir,
Your obedient servant,
(Sgd.) W. A. ROBINSON.

STATICS EXTRAORDINARY.

Statics are generally the bugbear of the poor W/T. Operator only but apparently during the R.34's trip the whole personnel aboard became more intimately acquainted with the properties of electricity in bulk than they altogether relished.

Following the text-book method of accumulating charges by rubbing together non-conducting substances of different material, the airship in friction with the surrounding atmosphere collected quite a lot, sufficient, at all events, to raise her potential to a value that was more than good for her at times.

Theoretically this charge should not have proved troublesome except in the event of meeting a passing cloud loaded up with the opposite quality, in which case the ensuing discharge might, with the assistance of the cargo of 2 million cubic feet of hydrogen, have caused quite a considerable spark.

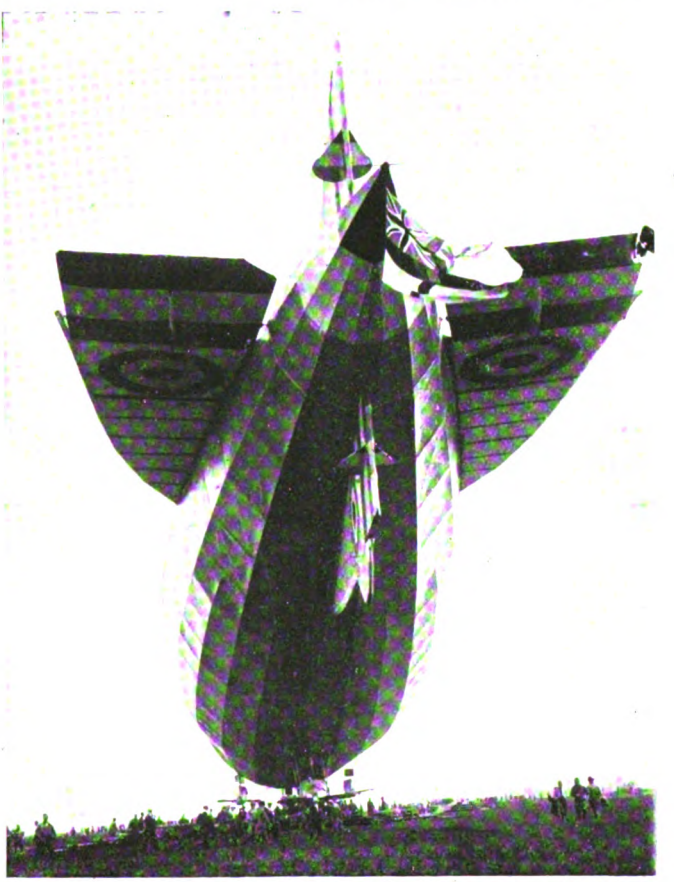

Photo by Topical Press

The R.34 Landing in Roosevelt Field, Mineola.

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Actually, however, whilst stopping short of causing a catastrophe, the superfluous freight appears to have fully maintained its characteristic "static" reputation by making itself a most thorough nuisance to all in the neighbourhood.

According to Faraday any such induced charge should have been purely superficial, and should have resided respectably on the exterior surface of the vessel, but according to the crew who ought to know, it did nothing of the kind. In fact several "other ratings" complained of being electrocuted with some severity, whilst the climax was reached when, as the record states, "one of the officers, on putting his hand into a bowl of water to wash, received a sharp shock." Everyone will agree that this was most unbecoming conduct, and it is understood that the whole matter is being investigated with a view to the necessary disciplinary action being taken.

This may or may not have the required effect, but at all events it will serve to warn our mutual enemy that he cannot with impunity disport himself on board H.M. Aerial Dreadnoughts in the same light-hearted spirit of malice that characterizes his dealings with ordinary common or garden wireless gear.

Photo by Sports and General

Constructing a Wireless Telegraphy and Telephony Station at Roosevelt Field, Mineola, for the Reception of the R.34.

The German Zeppelin Fleet.

In a recent lecture to the London Topographical Society, Colonel de Watteville gave some interesting particulars as to the development and use of the Zeppelin during the war.

The earlier Army type was a conspicuous failure, no fewer than five being lost in the first few weeks. The Navy then practically took control of construction, and concentrated their efforts in perfecting the type that was subsequently used in the bombing raids against this country.

Altogether some 120 Zeppelins were built by the enemy during the war period, but out of that total there were never more than 12 or 16 ready to take the air at one time.

The lecturer stated that directional wireless sets were carried by all the Naval airships with satisfactory results so far as navigation was concerned. On the other hand, it was the wireless gear that played traitor to the Hun, and proved a source of fatal weakness.

By a process of "diamond cut diamond" the same Zeppelin that was directed on its course by the help of wireless, was itself located and tracked by means of signals sent back

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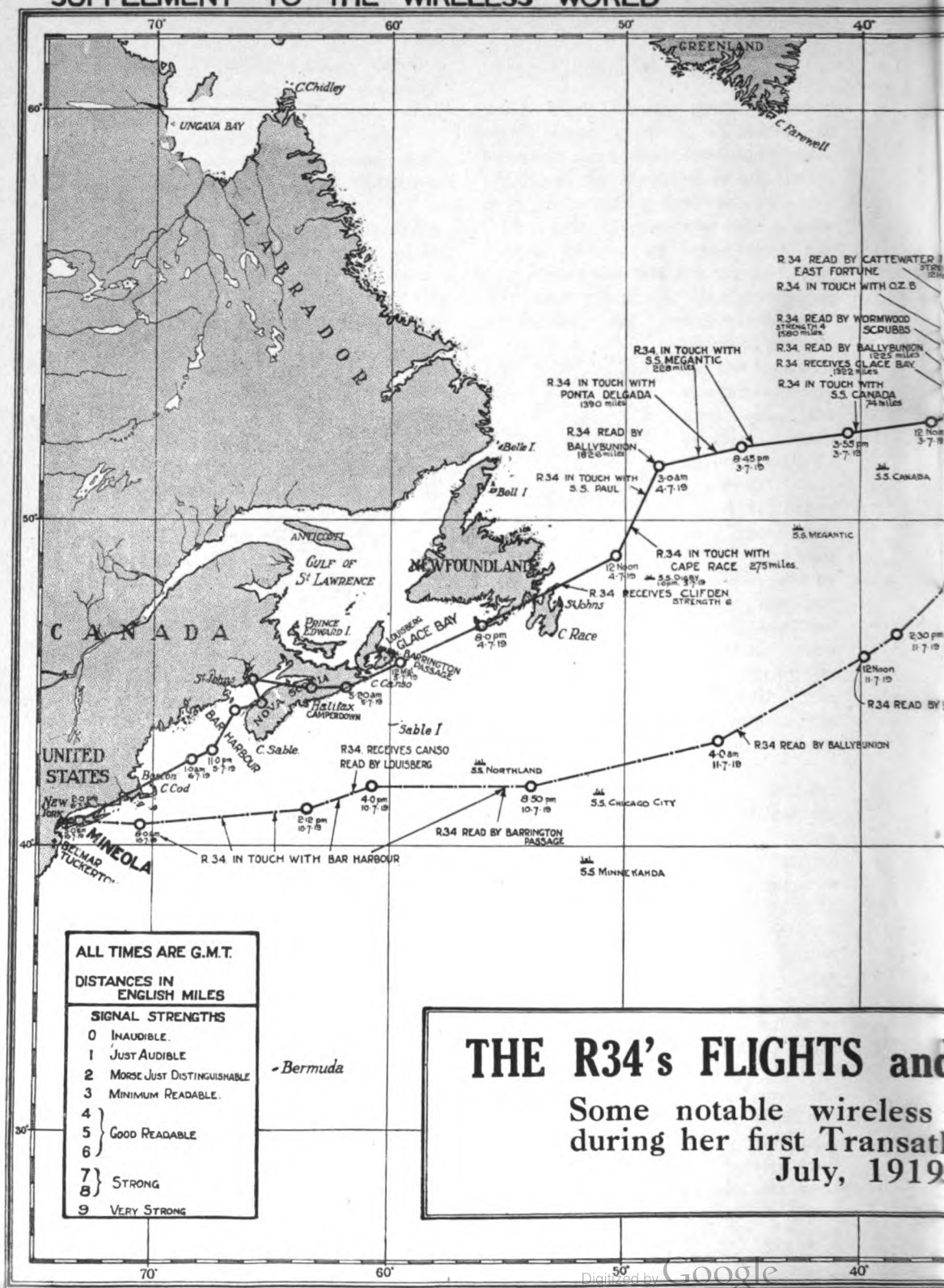

THE R34's FLIGHTS and

Some notable wireless
during her first Transat
July, 1919

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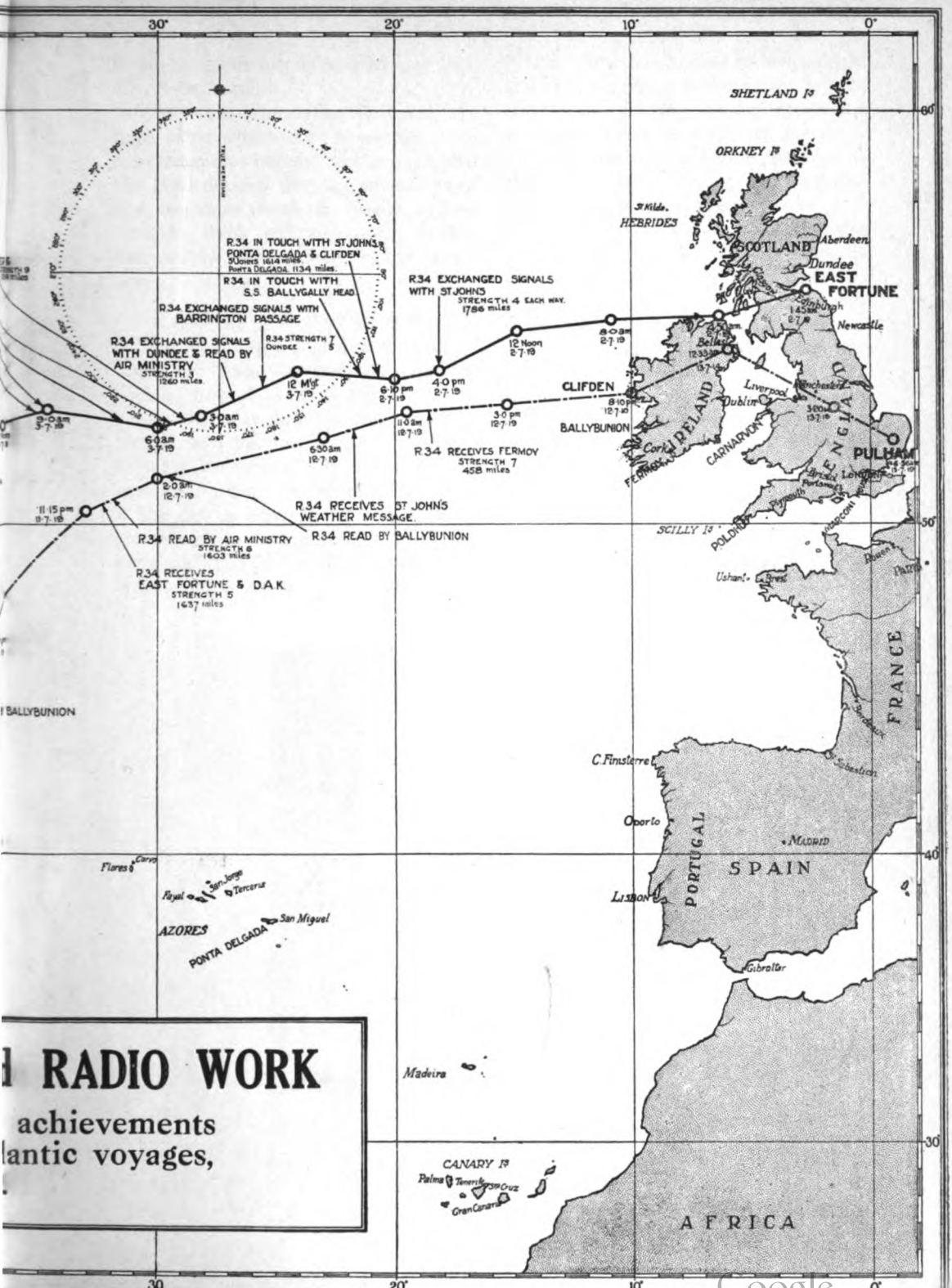

RADIO WORK

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to its base, but intercepted by our own directional stations.

With this information in hand, the time came when our preparations for their reception became so thorough that the Hun decided that the air-raid game was no longer worth the candle, and retired to think out an *ersatz* wireless that would only radiate in one direction.

A Floating Aerodrome.

The war has provided a number of " mystery " and " wonder " ships, but nothing to beat H.M.S. Argus.

She was only commissioned last September, and has had no opportunity of showing her worth, but she is the last word in floating aerodromes.

She carries between 25 and 30 aeroplanes as her complement. The "flying deck" is 240 feet long and 40 feet broad, and is 65 feet above the waterline.

The planes are housed in lower decks, and are hoisted up to the flying deck by elevators. During flying operations, the chart-house is sunk by means of hydraulic machinery below the level of the flying deck, leaving an absolutely clear and unimpeded space.

In order to provide an arresting device, the main elevator is lowered, leaving a large oblong hole across the flying deck. This is strung over with stout wires about the breadth of a landing-wheel apart. If the run of the plane after landing is excessive, the landing-wheels sink down between the wires as soon as she gets over the arrester. The under-carriage slides along on the wires, and the bus is brought to rest against the further lip of the elevator well.

This method only applies to the smaller craft. The heavier seaplanes alight near the mother ship and are hoisted aboard in the ordinary way.

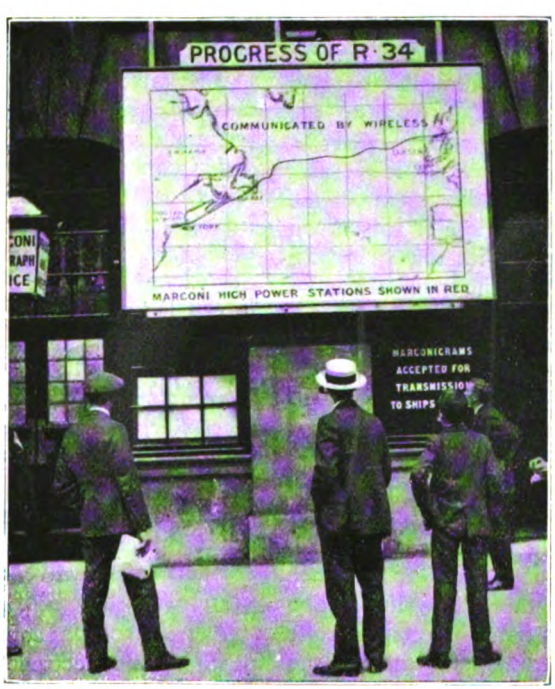
PROGRESS OF R·34
COMMUNICATED BY WIRELESS
MARCONI HIGH POWER STATIONS SHOWN IN RED
MARCONIGRAMS ACCEPTED FOR TRANSMISSION TO SHIPS

Photo by Sports and General

Chart outside Marconi House, Strand, showing the progress of the R 34 on her Atlantic Flights.

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The Library Table

THE OSCILLATION VALVE

By R. D. BANGAY.

London: THE WIRELESS PRESS, Ltd., pp. 215. Price 5s. net.

IN view of the enormous popularity enjoyed by Mr. Bangay's "*Elementary Principles of Wireless Telegraphy*," it is safe to say that radio workers and students will heartily welcome another book from his pen, for apart from the value of the information he conveys, Mr. Bangay without being a stylist writes with a force and a clarity peculiarly his own.

The discovery and development of the thermionic valve have revolutionised the practice of wireless communication to a far greater degree than the X-rays did that of surgery. As a detector and amplifier of electro-magnetic energy, the modern valve so well fulfils present requirements that the time has not yet arrived for us to look forward to the new invention which shall sweep it away, whilst as a transmitter it bids fair to displace to a very large extent the spark and the arc. There is still much to be said and done with respect to this instrument which in the space of five or six years has lifted wireless telegraphy to the high plane it now occupies, but the book under review is a notable step towards bringing wireless literature on a level with present theory and practice.

Here we have a volume of 210 pages illustrated with no less than 110 diagrams, and we are glad to note that, as is most fitting in a work of this nature, no space is wasted on half-tone blocks; too often these show little more than fine high light effects on the exteriors of instruments, whereas the reader is mostly concerned with the *interiors* and the wiring diagrams.

The greater part of the book treats of the oscillation valve as applied to receivers, and although the subject well merits the amount of attention devoted to it, one wishes that the total space could have been more generously shared with the section on the valve as a transmitter. However, many a man who thinks he knows a great deal about valves is destined to find that this book will provide him with food for an amount of thought and study he little anticipates. The author has not contented himself with a mere paraphrase of a compilation of facts torn from other books or from miscellaneous papers, but has produced a book which gives really "inside information" because he has got really inside his subject.

The first forty-five pages are given over to general considerations of the telephone receiver, the rectification of high-frequency oscillations, the principles of "beat" reception for C.W., tuning and the effect of damping on the shape of the resonance curve. Next, the vacuum tube is discussed generally in the light of the electron theory, the section concluding with a very full treatment of the Fleming valve. Twenty-seven pages are allotted to the three-electrode valve as an introduction to an explanation of its application to receivers, these pages including, we are pleased to see, some useful information about the effect of the mechanical proportions of the valve, and the "Magnification constant" of valves.

Pages 110-132 comprise an account of the three-electrode valve as applied

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to receivers, and are followed by sections on the valve as a magnifier, high-frequency magnification, and the reaction principle. Next in order comes "The application of the three-electrode valve to the Transmitter" and the book concludes with an article on the theory of the soft valve.

The treatment throughout is non-mathematical, thus rendering the book doubly attractive to the elementary student and the non-specialising amateur. The author possesses the happy knack of imparting knowledge easily; he neither refers his readers to a thousand and one other books nor takes refuge in a jargon which sends them to a scientific glossary and a mathematical expert. His book will win a great and deserved success because he has discerned and turned to account the supreme secret of teaching—the sacrifice of pedantry in the interests of the learner.

TRANSATLANTIC RADIO RECEPTION

A COMMUNICATION to the Franklin Institute by Major-General G. O. Squier, Chief Signal Officer, U.S. Army, deals with the results obtained in the course of extensive research work carried out by the Radio Development Section of the U.S. Signal Corps during 1918. The fundamental object was the investigation of the reliability of various receiving stations for transatlantic wireless from the point of view of interference both from atmospherics and from other stations.

Six experimental receiving stations were equipped with apparatus for the comparison of signal strengths using the shunted-telephone "audibility-meter" method, in conjunction with a simple detecting valve circuit, that could be used either direct, or in combination with either one- or two-stage low-frequency amplification.

Low horizontal receiving aerials were used throughout. When using a single wire aerial of this type it was found that the received signal audibility was proportional to the length of the wire raised to the power of 1·2.

An examination of the extensive records obtained, indicated that the signals from a given station [Signals from Lyons, YN, were largely employed in these tests] may show a comparatively high audibility value at one or more of the stations on a certain date, and at the same time a low value at another station, and *vice versa*. It was also evident that the signals from a given transmitting station may have a high audibility value at a given receiving station on a certain date, while signals from some other station are comparatively weak at that particular time, and *vice versa*. It was also found that a given station might show a comparatively satisfactory signal audibility for a period of time of the order of a month or several months, while during some other period the signal audibility would be found to be low.

There was also some evidence that cloudiness over the Atlantic in the great circle between the two stations, resulted in low signal values at the receiving station. A period of high signal audibility in March (1918) was found to coincide with a period of abnormally high electrical conductivity of the air at the receiving end.

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122,640. Wireless signalling. Lowenstein, F., 397, Bridge Street, Brooklyn, New York, U.S.A. January 20th, 1919. No. 1392. Convention date, January 19th, 1918. Not yet accepted. Abridged as open to inspection under Section 91 of the Act (Class 40 (v)).

In multiple quenched spark-gap apparatus for producing high frequency oscillations by the condenser discharge system, the multiple gas is built up of a series of readily removable and replaceable units, each unit comprising one or more pairs of disc electrodes with annular sparking-surfaces and sheet-metal cooling-fans. Switch mechanism is provided for varying the number of gaps in circuit in relatively large, and in small, steps. Fig. 1 is a side elevation, and Fig. 3 a plan, of one arrangement, a separated unit being shown in Fig. 6. Silver sparking-rings 22 are secured to the adjacent surfaces of discs 20^a. 21^a of brass or other metal. The discs are flanged as shown and are secured to each other by a bronze stud 23^a, which is screwed into one member and has a head bearing against a pressure washer 24^a. An insulating-washer separates the pressure washer 24^a from the disc 21, and an annular insulating-member 30 separates the two discs 20^a, 21^a. The pressure washer may be varied in shape or may be omitted. The stud passes through a large opening in the disc 21^a, and the chamber in which the sparking takes place is air-tight. The cooling-fins are formed of rectangular sheets 31, preferably of copper, with circular openings to fit around the discs 20^a, 21^a, and with their vertical sides 33 flanged and overlapping, thus forming two or more narrow vertical tubes through which a draught of cooling-air will readily pass upwards. Sets of holes 311 in the cooling sheets 31 enable the sheets to be correctly aligned and also ensure that the insulator 30 is placed in the central position. The insulating-frame for supporting the sparking-units comprises a pair of end plates 35 connected by horizontal bars 36, 36^a. Spaced along these bars are metal brackets 39 having pointed upper ends 40 and pairs of spring contact members 42 projecting downwards and in an inclined direction. When the gap units are removed, these contact members engage at their lower ends 44, and when a spark-gap unit is pushed downwards between the contacts, the cooling-fins 31 separate the spring members 42, thus putting the inserted unit in circuit. For varying the number of

FIG. 1.

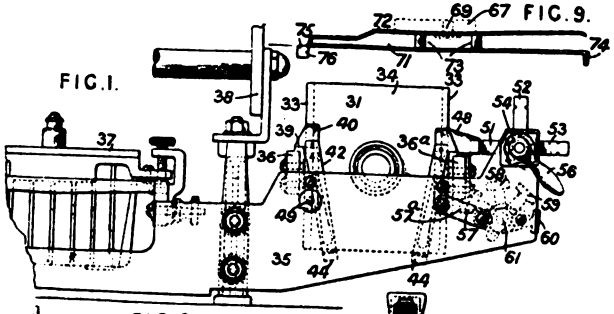


FIG. 9.

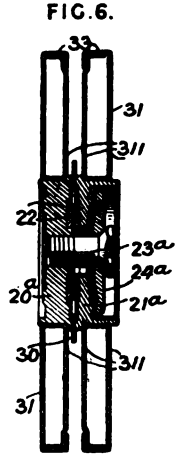


FIG. 6.

FIG. 3.

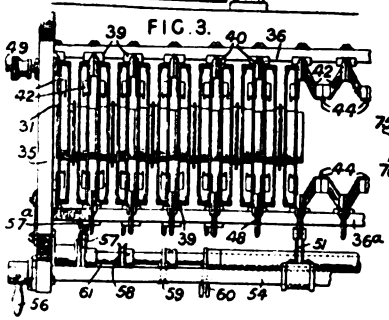
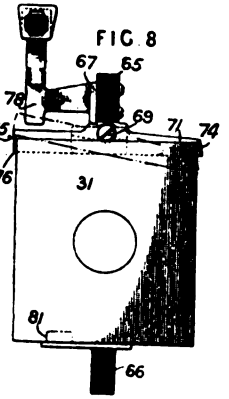


FIG. 8



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gaps in circuit in relatively large steps, a switching-arangement is provided comprising a longitudinal shaft 54 operated between limit stops by a handle 56 and carrying three contact-arms 51, 52, 53 separated angularly and axially and arranged to make contact with projections 48 on the brackets 39. One terminal of the sparking-set is connected electrically to the shaft 54 so that all gaps to the right of the operative contact-arm 51, 52 or 53 are short-circuited. The arms are adjustable along the rod 54 and are locked by suitable detents. An auxiliary short-circuiting device giving a finer adjustment comprises a shaft 61 with angularly-displaced contact-arms 57, 60 placed opposite the successive units at the left-hand end of the set. The shaft 61 is in electric connection with the terminal 49, and by placing any of the switch arms 57 in contact with the corresponding member 57^a, the gaps to the left are short-circuited. The contact members 57, 60 have wide engaging faces in order that one may engage before the next one has disengaged. The frame supporting the gap units also carried a condenser 37 and a support 38 for the transmitter inductance coils. In a modified arrangement spring clamps bearing frictionally on the shafts 61, 54 are connected respectively to the condenser 37 and to a switch arm of a variable inductance. A modified form of holder for the gap units is shown in Figs. 8 and 9. Longitudinal bars 65, 66 of insulating material carry spring contact members 71 and distance-blocks 81 respectively. The spring members are centrally pivoted at 69 to brackets 67 and comprise two parallel arms 71, 72 connected by cross-pieces 73. The arm 71 has a stop 74 at its rear end and a stop 76 and lip 75 at its front end. When it is desired to remove a gap unit 31, the lip 75 is raised and the rear stop 74 pushes the unit forwards. At the same time, the arm 71 makes contact with a projection 78 on the bracket 67 corresponding to the adjacent unit, so that the circuit is maintained.

PERSONAL NOTES

NEW FELLOW OF THE I.R.E.

MAJOR RUPERT STANLEY, R.E., well known as a radio expert and the author of a book on wireless telegraphy, has been elected a Fellow of the Institute of Radio Engineers. Major Stanley is Professor of Electrical Engineering at the Belfast Technical Institute, but since 1915 has been engaged in wireless work, both experimental and instructional, with the British Army in France. He is a Chevalier of the Legion of Honour.

* * *

MENTIONED IN DESPATCHES.

The names of the following wireless officers and N.C.O.'s. appeared in the "London Gazette" of June 3rd, 1919, "mentioned in despatches" for "valuable services rendered":—

Lieut. J. W. Bailey, M.C., R.E.,
T./Lieut. J. A. Cooper, R.E.,
T./Lieut. A. H. E. Rogers, R.E.,
73402, Sgt. P. Greig,
244326, Cpl. (A./Sgt.) H. W. Shuker,
152319, L./C. (A./Cpl.) F. Whyte.

* * *

MARCONI MAN WINS D.F.C.

Lieut. C. A. Moth, now demobilised and on the staff of Marconi's Wireless Telegraph Co., Ltd., has recently been decorated by H.M. the King with the Distinguished Flying Cross for his intrepid work as a night-bomber in France. He has taken part in forty-two night raids over the German lines and towns, and although wounded in October, 1918, won his decoration in November, 1918, for a fine flying and bombing feat.

* * *

AN EX-AMATEUR ON THE R.34.

Lieut. R. F. Durrant, the wireless officer of the R.34 during her recent great flights to America and back, was originally an amateur wireless worker and a member of the North Middlesex Wireless Club.

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The Construction of Amateur Wireless Apparatus

This series of Articles, the first of which was published in our April number, is designed to give practical instruction in the manufacture of amateur installations and apparatus. In the following article the author deals with the important question of CRYSTAL AND VALVE RECEIVING CIRCUITS. *The Wireless Press, Ltd., has arranged with Marconi's Wireless Telegraph Co., to supply complete apparatus to the designs here given, as soon as Amateur restrictions are released.*

Article Six.—CRYSTAL AND VALVE RECEIVING CIRCUITS.

WE propose in this article to give the amateur a résumé of the various types of crystal and valve receiving circuits in general use. It will not be possible to give details of all the arrangements it is possible to employ, but if the reader has obtained a sound working knowledge of the subject he will have no difficulty in adapting any of the examples given to his own particular requirements. The functions of a receiving circuit are (a) to gather energy from the ether wave and store it in suitable oscillatory circuits, (b) to convert this stored electrical energy into sound waves in order that it may be detected by the ear. The three-electrode valve may be used as an amplifier. In the second case it may be tions. In the first case its function is to increase the available energy in the oscillatory circuits, and since the energy is in the form of high frequency currents, when the valve is used in this connection it is known as a high frequency amplifier. In the second case, it may be used to amplify the current which is flowing in the telephone circuit of the receiver, and as this current is of note frequency a valve used in this manner is known as a note magnifier. A third use for the valve occurs in the reception of continuous waves, in which case local oscillations produced by the valve are used to give beat tones with the incoming signal in order to render it audible in the telephone receivers.

We would draw the amateur's attention to the fact that in all the receiving circuits illustrated we have indicated a telephone transformer to be used in conjunction with low resistance telephones in preference to the employment of high resistance telephones direct. We would urge the amateur to make a practice of always using this arrangement as insulation troubles in valve circuits are thereby avoided. Imagine that we are employing high resistance telephones in the sheath circuit of a valve requiring a hundred volts or more on the anode. Since the negative terminal of the plate battery will be connected to the filament circuit, if the telephones happen to be on the positive side of the battery, there will be the full 100 volts between the metal parts of the telephone and the windings owing to leaks between the filament battery and the table, etc. This high voltage is very likely to break down the delicate insulation of the telephone

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windings, thereby rendering them useless. The trouble is avoided by using a telephone transformer. It is quite easy to make the insulation between the windings of the transformer of a high order, and since any voltage which may arise from the above-mentioned cause will be between these windings breakdowns are avoided. The combination of telephone transformer and low resistance telephones is quite as sensitive as high resistance telephones, and therefore the amateur is recommended to use the arrangement even in simple crystal circuits.

In Figs. 1, 2, 3 and 4 we have indicated four representative types of receiving circuit. For the sake of clearness in each case a simple crystal detector is shown. Fig. 1 is a single circuit receiver consisting of an aerial tuned to the desired wavelength by means of a variable inductance; the rectifier circuit, composed of a crystal, a potentiometer and a telephone transformer, being connected directly across the inductance from aerial to earth. This is about the simplest type of receiver it is possible to devise. Its efficiency is low, but it is quite suitable for receiving time signals, press, etc., from high-power stations.

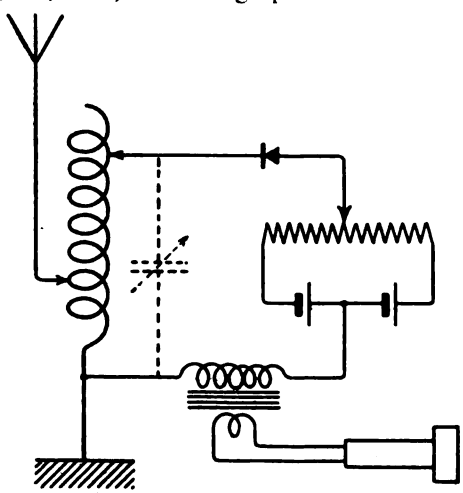

Fig. 1.

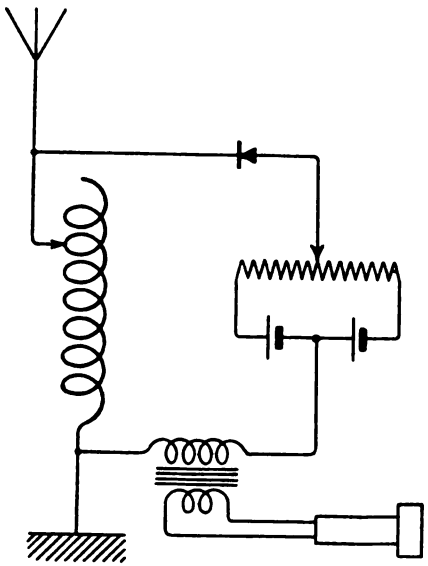

Fig. 2.

Fig. 2 illustrates the well-known "double slider" circuit; in this case the crystal circuit, instead of being connected directly across the aerial-earth terminals of the tuning inductance, is connected to a second tapping on the inductance which is adjustable. On sliding this second tapping to and fro a best point can be found on the inductance at which position the loudest signals are obtained. The arrangement is really an auto-jigger, the self capacity of the coil acting as the secondary tuning condenser. For very long waves it is sometimes necessary to connect a small variable condenser from the second slider to earth as indicated by the dotted lines. This circuit is considerably more efficient than that shown in Fig. 1, but it leaves much to be desired from the point of view of jamming. A great deal depends upon practice in manipulating the sliders to obtain the best effects. In Fig. 3 is shown one of the best and most efficient receivers that can be devised. It consists of an aerial tuned by means of a variable condenser and a variable inductance to the wavelength

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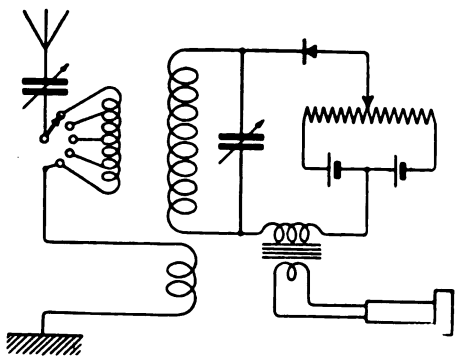

Fig. 3.

to be received. A coupling coil is also provided in the aerial circuit by means of which it can be magnetically coupled with the jigger secondary, composed of a long inductance tuned to the same wave as that of the aerial by means of a small variable condenser. The crystal circuit is connected directly across the terminals of this latter condenser. In this case we have two separate and distinct oscillatory circuits, each of which can be designed to perform its particular functions in the most efficient manner. In order to secure the greatest possible freedom from jamming the arrangement shown in Figure 4 is sometimes employed. This is simply the two-circuit receiver which we have just explained with the difference that instead of the energy being transferred directly from the aerial to the detector circuit it is handed on via the intermediate circuit A, this latter consisting of two inductances connected in parallel across a variable tuning condenser. By very accurate tuning of all three circuits, and by working with the weakest possible couplings the greatest freedom from jamming can be secured. It is worth while noting that in order to obtain a large range of wavelength with a given pair of inductances and a single variable condenser, short waves can be obtained by the parallel connection shown at A, whilst the series connection B will give a second range of longer waves. If the two inductances are equal, any particular reading on the variable condenser will represent just double the wavelength when the B connection is employed as that obtained on the A connection. Generally the amateur will be quite satisfied with the results of the circuit shown in Fig. 3, and we recommend this for all ordinary requirements.

In regard to the type of crystal to be employed we strongly recommend the reader not to waste time trying out all the various combinations of minerals which have been used as detectors. The only really practical crystal to employ is carborundum. It may not be quite as sensitive as some combinations when a lucky adjustment is secured, but its steadiness and reliability far outweigh any such advantage which may be possessed by any of the other types. It is necessary to use a potentiometer in connection with the carborundum crystal, but a good carborundum crystal, used on properly designed circuits with a correct adjustment of the potentiometer, is the most reliable and satisfactory detector in existence.

The design of the circuits is most important to secure the best results. The aerial tuning condenser should not be of too small a capacity, say, not less than .002 microfarads. Of course, a variometer of one of the types described in the last article may be used to give the necessary continuous variation of tuning between the tappings on the aerial tuning inductance, provided that the wave to be received is not shorter than the natural wavelength of the aerial. A series condenser is essential if it is desired to receive waves shorter than the natural wavelength of the aerial. Do not wind the inductances for the aerial circuit with a wire of very fine gauge. No. 20 or 22 S.W.G. is about the smallest that can be used without loss of efficiency. Always use

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double silk-covered wire, single silk is liable to have deficient insulation in places, and a short-circuited turn may result in a close wound coil. We have already pointed out that the coils should be wound in only one layer for the best results.

The secondary circuit, across which the crystal or valve is connected should be designed to have the maximum possible ratio of inductance to capacity. That is, the inductance should be large and the tuning capacity small. The amateur will do well to make it a hard and fast rule that his secondary tuning condenser shall under no circumstances exceed .0003 microfarads in capacity. This applies to receivers employing a carborundum crystal as detector, or a three-electrode valve as a high frequency amplifier or detector. It is not so important to keep this condenser small in the case of a heterodyne continuous wave receiver, or when using certain low resistance mineral combinations as the detector. Quite fine wire may be used for the secondary inductance, No. 28 double silk-covered is suitable, and the coil should be wound evenly with the turns close to each other. It is important to notice that the circuit should be connected up exactly as shown in the diagrams. One end of the secondary circuit must go straight to the crystal or valve in order that the maximum possible potential may be applied to the detector. This point is essential to the satisfactory working of the receiver, as if any extra capacities are introduced at the high potential end of the jigger signals will suffer in strength. The insulation of the jigger secondary from the table or support should be kept as good as possible, if an experimental circuit is being made up with the coils lying loose on the table, it is desirable to insulate the jigger secondary by placing pieces of

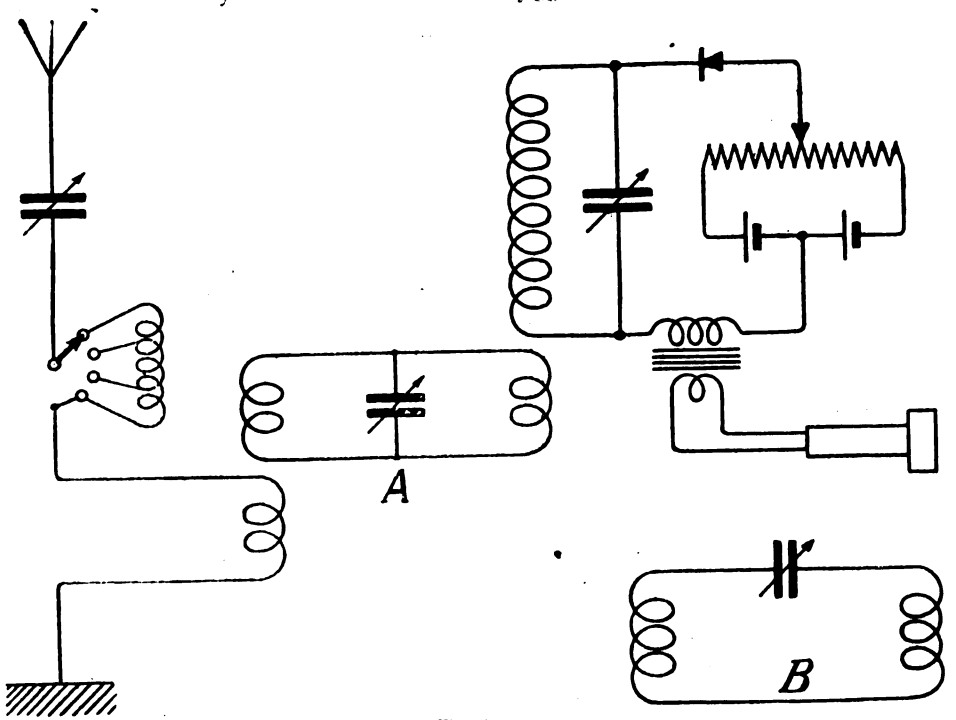

Fig. 4.

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ebonite underneath it. The separate halves of porcelain cleats form very convenient insulators for supporting any apparatus when experimenting.

The intermediate circuit A fig. 3) should have a fairly small ratio of inductance to capacity. The condenser may be of .01 microfarads or more capacity. If the amateur does not possess a variable condenser of this large capacity, the same result can be obtained by placing a number of fixed condensers in parallel with a small variable condenser. If the fixed condensers are arranged on a switch so that any number can be connected at a time a continuous variation of capacity up to any desired value can be obtained. It is preferable to make the two inductances in the circuit equal in value, and the reader should remember that the effective inductance in the circuit is half the inductance of one coil when the parallel connection shown at A is employed. Consequently when calculating out the circuit each coil must have an inductance double the value required to tune to the receiving wavelength with the condenser in use. If possible stranded wire should be used for these inductances for the best results, but quite good effects can be obtained from intermediate circuits wound with No. 22 double silk-covered copper wire. When using an intermediate circuit, care should be taken that there is no direct electrostatic or magnetic coupling between the aerial and the jigger secondary circuit. The aerial coupling coil and tuning inductance should be some distance away from the jigger secondary. A good test to settle this point is to remove the intermediate circuit altogether, when it should not be possible to hear the strongest signals or atmospherics in the phones. If any signals come through it is an indication of direct coupling and the coils should be rearranged until silence is obtained. If the intermediate circuit is a good one, the tuning on the intermediate condenser should be sharp, and it should be possible to work with very loose couplings between the various circuits.

It is sometimes a little difficult to find a station on an intermediate circuit receiver owing to the number of adjustments involved. The best method of procedure is to take away the intermediate circuit altogether as a start, coupling the aerial directly to the secondary circuit by means of the aerial coupling coil. The aerial and secondary can then be tuned up to the incoming signals by adjustment of the aerial tuning inductance and the condensers. When the best signals are obtained separate out the aerial coupling coil and the secondary circuit until no signals can be heard, making no change in the tuning. The intermediate circuit can then be introduced as shown in the diagram, and tuned up to the signals by means of its variable condenser. Then by careful adjustments of all couplings and tuning condensers the complete circuit can be brought into exact resonance with the wave being received. Keep all couplings as loose as possible to get the best effect in the matter of cutting out jamming.

In our next article we hope to give the amateur some simple types of valve receiving circuits. It will be understood that the general remarks we have made above, although given in particular for crystal receivers, apply also to the circuits used in conjunction with the three-electrode valve. Although it is not as necessary to reduce all resistances in the oscillatory circuits associated with the valve, it is nevertheless desirable to do so. The notes concerning the ratio of inductance to capacity of the jigger secondary apply with equal force to the valve circuits, and the amateur will obtain the best results by building his circuits in correct proportions.

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Questions and Answers

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless telegraphy. Readers should comply with the following rules: (1) Questions should be numbered and written on one side of the paper only, and should not exceed four in number. (2) Queries should be clear and concise. (3) Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before.* **(4) The Editor cannot undertake to reply to queries by post.** (5) *All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or if so desired, under a "nom-de-plume."* **(6) Will readers please note that as amateurs they may not at present buy, construct or use apparatus for wireless telegraphy or telephony. (7) Readers desirous of knowing the conditions of service, etc., for wireless operators, will save time by writing direct to the various firms employing operators.**

C.E.S. (Sussex).—Asks: (1) How much closer can the jigger primary and secondary of a 1½ K.W. set be coupled when using a rotary discharger than when using a fixed discharger?

Answer.—It is impossible to give any definite figures for this coupling without measurement on the actual set, as the length of aerial and the amount of A.T.I. for any given wavelength varies with each station.

There would not in any case be much difference between the two couplings, as with a well-adjusted fixed discharger the oscillations are fairly well damped.

Question (2).—What would be the approximate transmitting range obtained with this closer coupling?

Since the tighter coupling obtained as explained in (1) is small, there would be little increase in the transmitting range.

Question (3).—Does the insertion or removal of the whole of the A.T.I. affect the coupling between the open and closed oscillating circuits?

Answer.—Yes, the insertion of the whole of the A.T.I. will decrease the coupling. The coupling of any two circuits is determined by

$$k = \frac{M}{\sqrt{L_1 L_2}}$$

where k = coupling
M = Mutual inductance of primary and secondary coils, and
L_1 and L_2 = Self-inductance of primary and secondary coils respectively.

Hence it will be seen that if either L_1 or L_2 are increased or decreased, k will be either decreased or increased.

On a ½-K.W. ship set if the coupling is set at 6 with no A.T.I. and a single wave is obtained, the coupling may have to be increased to 10 when all the A.T.I. is used.

Question (4).—The unsteadiness of the asynchronous disc discharger is due to successive spark discharges not being timed uniformly. In an asynchronous discharger the successive discharges of the condenser are not of constant amplitude, and therefore successive spark dischargers are not of equal power. By very careful adjustment of the speed of the disc the gap can be made to discharge the condenser at points of equal amplitude which results in a more uniform note and a steadier disc position. It is, however, doubtful if any asynchronous disc can be made to run as steadily as a synchronous disc.

R.J.T.M. (Surrey).—Wishes to know if with a secondary winding of a receiver sliding into the A.T.I. the bottom of the A.T.I. should be connected to one end of the secondary coil.

Answer.—No. The bottom of the A.T.I. winding should be directly connected to earth, and not to the secondary inductance.

With this exception the connections are the same as the diagram sent with the question.

See that the secondary tuning condenser be not more than 0.00025 mfd. capacity.

G.E.H. (North Wales).—Before proceeding to answer our correspondent's many questions on Magnifying valves we should like to point out that owing to the limited amount of space at our disposal we are compelled to limit the number of questions from each correspondent to not more than four. However, as the following questions are of general interest, bearing as they do on a subject comparatively new to the bulk of our readers, we think it would be in their interests to make an exception in this case.

All the questions relate to the action of the Round valve when used on a Franklin circuit, a diagram of the connections being reproduced.

Question (1).—Why is it that placing the A.T.C. between the aerial and the A.T.I. gives stronger signals than when the A.T.C. is placed between the A.T.I. and earth?

The reason for the decrease in the strength of signals when the A.T.C. is connected between the A.T.I. and the earth is because in this position the condenser is shunted by the battery leakage to earth, which is equivalent to connecting a high resistance across the condenser. When the A.T.C. is placed between

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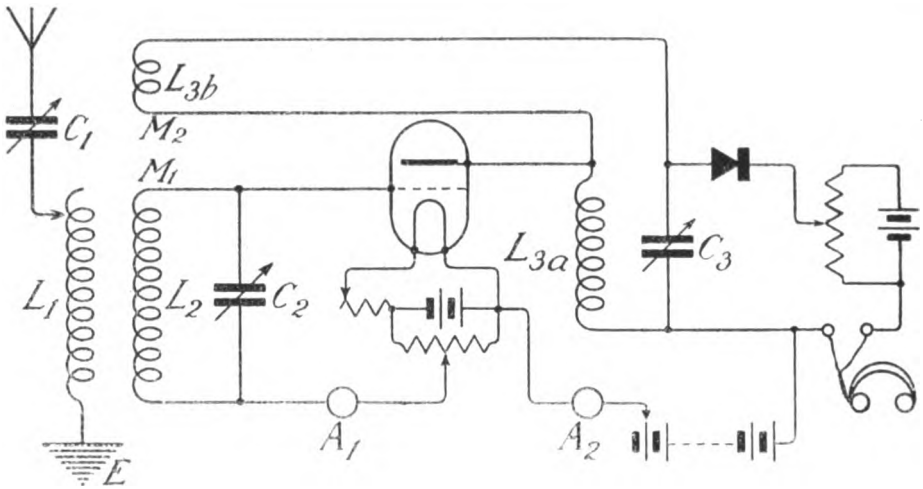

the aerial and the A.T.I. the condenser is unshunted by any external path, and, therefore, none of the strength of the received oscillations is lost.

Question (2).—Is the coupling between L_{3b} and L_2 negative or positive?

That is, when L_2 is impulsed by a momentary current so that the North pole of a magnet is towards the letters M_2, is the resulting impulse through L_{3b} in such a direction that the North pole of coil L_{3b} also points towards M_2?

Answer.—It is impossible to say what is the polarity of the coil L_{3b} with respect to the coil L_2. The coil L_2 is only impulsed by coil L_{3b} when the currents in the plate and grid circuits are in phase, that is when they are in tune, and this phase relation will depend on the adjustment of the plate condenser C_3.

Question (3).—As the strength of a signal depends on the total charge in C_3 for rectification by the crystal, how can the greatly increased strength of signals be accounted for when the valve is softened until the grid current shows backlash?

Answer.—This is due to the plate current curve being steeper for a soft valve than a hard one, hence a small variation in the voltage of the grid will produce a greater variation in the plate current.

Question (4).—Is the howl noticed in tightening M_2 a rectified beat note? If so, why cannot it be obtained when the valve is hard?

Answer.—Yes, the howl is a rectified beat note, but this cannot be obtained with a hard valve, as the valve is not working at its magnification point.

Question (5).—Why should there be an improvement in the strength of signals when receiving short wavelengths on a low resistance circuit?

Answer.—The strength of signals depends on the amplitude of the incoming wave, and if the circuit possesses high resistance then the oscillations are damped out quicker than they would be in a circuit of low resistance. When reaction is used the amplitude of the incoming waves is increased, but the amplitude is not increased to such an extent in a high resistance circuit as in a low resistance circuit.

Our correspondent proceeds to state that it is much easier to "soften" a valve when the crystal is on a good working point, and that if the valve is softened the crystal potentiometer slider must be moved, thus using a different point on the rectifying curve of the crystal.

We have not found in any receiver using Franklin's circuit that the valve is easier to soften when the crystal is on a good working point, neither have we noticed that when the valve is softened the crystal potentiometer requires readjustment. We can only suggest that before softening the valve the circuits were not in the best adjustment.

The crystal has no effect whatever on the valve's internal condition.

Question (7).—Why is it possible to use a softer valve for radio frequency amplification than for "note" amplification?

Answer.—Because if a soft valve is used for "note" magnification it is much more difficult to prevent "singing" in the telephones than if a hard valve is used.

W.V.M.P. (Ealing).—States, in view of our recent remark that "the exact action of a rectifying crystal is not yet understood," that he has always held the opinion that the action was due to the polarization of the incoming waves, and asks if this is a possible explanation?

Answer.—The polarization of the incoming waves cannot account for the rectification action of a crystal detector. When these waves excite a receiving aerial, oscillatory currents are set up in the aerial circuit and it is these oscillatory high frequency currents

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which are rectified into continuous current impulses by the action of the crystal.

Has W.V.M.P. in mind the electrolytic polarization of the crystal itself? According to G. W. Pierce in his "Principles of Wireless Telegraphy," the action of electrolytic polarization of the crystal together with the production of a thermo-electro-motive force, due to this polarization, plays an unimportant part in the rectifying properties of a crystal.

A.B. (Newcastle-on-Tyne).—Wishes to know if it would be possible to send a parallel beam of wireless rays from a parallel reflector to fall on a tube of filings about half a mile away. He wishes the rays to fall directly upon the coherer thus dispensing with a reflector at the receiving end. Also would such a coherer act if the rays fall in only one part of the coherer.

Answer.—Our correspondent evidently wishes to revert to the early days of Wireless Telegraphy when Marconi first used reflectors, but subsequently gave them up on account of their becoming too large for commercial work.

Before we say anything about the transmitting end let us see about the receiving end. Our friend evidently does not know that before any detector can indicate the presence of electromagnetic waves it must be included in a circuit round which induced currents can flow. Hence some auxilliary apparatus must be used in conjunction with the detector. A receiver in its simplest form consists of an aerial and the detector. Now before any induced currents caused by an electromagnetic wave can flow in a receiver, the receiving circuit must be tuned to the wavelength of the transmitting circuit. In our simple receiver of an aerial and detector this can be accomplished by varying the length of the aerial, thereby altering the inductance and capacity of the circuit. A.B. makes no mention of any receiving apparatus except the coherer and from his question it seems that he expects the "wireless ray" to excite oscillations in the detector alone. Hertz and Marconi in their original experiments used a "resonator" at the receiving end, the frequency of the resonator being so adjusted that the circuit would oscillate to the wavelength of the transmitted waves.

As regards the transmitting apparatus, we think that A.B. will experience considerable difficulty in obtaining a "parallel wireless ray" half a mile long.

Electromagnetic waves can be reflected by the use of metallic sheets.

SERGEANT INSTRUCTOR (Wigan).—Asks (1) If a Fleming valve can be made out of a 4V., 5 amp. metal filament ash lamp?

Answer.—We see no reason why a Fleming valve should not be made out of a flash lamp, but it would have to be done by a very skilled glass-worker.

Question (2).—Is it better to have a high or low vacuum valve? It is impossible to give a definite answer to this question as it depends on the purpose for which, and the circuit in which, the valve is to be used.

Question (3).—Is a Topler mercury pump suitable for exhausting the bulb?

For exhausting the bulb of a Fleming valve or any other valve which does not require a vacuum of a higher order than about .000012 mm. a Topler pump is suitable. For valves requiring a vacuum of a higher order, as is the tendency in modern valve practice, a Topler pump is not suitable and liquid air is often used.

(4) We regret we cannot spare the space to describe how a valve is used in a transmitter, but our correspondent can find full information on this subject in any recent book on Wireless Telegraphy.

C.H.G. (Matlock).—(1) The connection for a single circuit receiver using a valve to magnify the received signals, and rectifying by means of a crystal, are given in answer to Capt. de la R. in the May issue of the WIRELESS WORLD. Diagram 4 is the same as Diagram 3 except for the addition of a reactance coil in the sheath circuit.

The inductance and condenser are included in the sheath circuit in order to do away with the necessity of producing a rectified current in the sheath circuit. Under these conditions the grid potential can be adjusted so that the received oscillations will produce the greatest change in the sheath current. The sheath oscillatory circuit is tuned to the incoming signals and the current flowing in this circuit is rectified by the crystal.

It is not essential to have a variable condenser in the sheath circuit, but it is far preferable.

Question 2.—The easiest way to make a reactance coil is to wind some wire about No. 34 S.W.G., D.S.C., on an ebonite former. Let the former be of smaller diameter than the A.T.I. Connect the lower end of the reaction coil to the plate of the valve, and insert reaction coil in the earth end of the A.T.I. It will soon be found by experimenting whether there are enough turns on the reaction coil.

It is necessary to be able to tune the sheath circuit if a crystal is used as a rectifier, but it is not necessary to have two inductance coils. The reaction coil with a condenser across it suffices for the sheat oscillatory circuit. This condenser must be of small capacity, not more than about .00025 mfd.

Question 3.—*Case* A: 600 metres. Probably EGE, the military station at Barcelona.

Case B: 2,200 metres. Probably Nantes.

Cases C, D, E *and* F: Cannot identify. Why not listen for their call signals, which are much more reliable evidence.

"DORRAN" (Aberdeen).—Asks: (1) The use of the sheathed coil connecting the D.F. to the type 55 Receiver, and the tin foil connected to the casing of the receiver?

Answer.—The use of these sheathed coils enables the D.F. Apparatus to be used with greater accuracy than would be the case without them. We regret, however, we cannot go into the full details of why this is so owing

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to questions of space, but the matter will, in all probability, be dealt with in a future number of the WIRELESS WORLD.

(2) Requires details of the R.A.F. generator with two commutators used for wireless telegraphy.

This machine is a self-exciting D.C. Generator. The armature is wound with two separate windings, one, the low tension winding, the other the high tension winding. The L.T. winding is connected to a commutator and supplies current to a field magnet winding and also to any external circuit for the purpose of charging cells or lighting the filament of a valve.

We regret we are not at liberty to give our correspondent the connections at present, and suggest that he keep his eye on the WIRELESS WORLD, where further information may, in due course, be published.

A.O.G. (Dover).—(1) The majority of D.F. Stations at present in commission are controlled by the Admiralty, to whom application should be made.

(2) The system mostly in use at present is the Bellini-Tosi.

QUERY (Gt. Yarmouth).—Asks: (1) If placing the tuning lamp in series with the aerial, instead of in parallel, would render the aerial circuit non-oscillatory?

Placing the tuning lamp in series with the aerial would not render the circuit non-oscillatory, but owing to the increased resistance of the aerial circuit, the oscillations would be more damped and, therefore, would be weaker in strength.

We quite fail to appreciate Query's remark that "the lamp would be burned out." If he tried transmitting with this arrangement most certainly it would, but we hope our friend is not under the impression that it would be burned out by any received wave, no matter what the signal strength be.

(2) How is it that moving the D.C. brushes of a 1½ K.W. rotary converter into the neutral position causes an increase in armature speed, with a consequent rise in A.C. volts?

Answer.—In the first place owing to the magnetisation of the armature, the magnetic field due to the field magnets is distorted. This distortion causes the neutral position to be behind the midway between poles position, and it is in this position that the brushes must be set in order that there shall be minimum sparking. Now moving the brushes against the direction of rotation of the armature will increase the speed of the armature while moving the brushes in the direction of rotation will decrease the speed of the armature. This increase or decrease in speed is due to the resultant magnetic field being either weaker or stronger than when the brushes are in the neutral position.

Now in a converter with a common winding the maximum voltage of the A.C. side is equal to the voltage supplied to the D.C. side, so that the R.M.S. value of the A.C. voltage is equal to $\frac{\text{D.C. volts}}{\sqrt{2}}$.

Obviously then an increase in armature speed in a weakened magnetic field cannot give rise to an increase in A.C. volts, and we suggest that Query repeats the experiment, taking greater care with his readings.

* * *

Mr. F. G. Butler, 37 Harroway Road, York Road, Battersea, wishes to get into touch with some one residing in S.W. London, who will give him buzzer practice. He is willing to pay, but is not prepared to pay at the rate usually asked by training colleges.

SHARE MARKET REPORT.

Business has been fairly active in the shares of the Marconi group during the past month. The ordinary shares have been subjected to sharp fluctuations over the arbitration award and the annual meeting of the Company, but have now settled into a steady market, and prices are well maintained.

Prices as we go to press (August 15th):

Marconi Ordinary, £5 15s. od. (extra div.)
Marconi Preference, £5 os. od. (extra div.)
Marconi Marine, £3 5s. od.
American Marconi, £1 9s. 6d.
Canadian Marconi, 15s. 6d.
Spanish and General, 14s. od.

WANTED. "WIRELESS WORLD" numbers 66/67/71. Fair price given.—Box "N" WIRELESS WORLD, 12 and 13, Henrietta Street, Strand, W.C. 2

INSTRUCTOR in Wireless Telegraphy wanted. Send copies of testimonials and state salary expected to the Principal Atlantic Wireless and Submarine College, Caherciveen, Co. Kerry.

PATENTS, Inventions, Trade Marks.—Advice and handbook free.—King's Patent Agency, Ltd., 165, Queen Victoria Street, London, E.C.4.

WANTED the following numbers of the "Wireless World":—April, June, 1913; June, July, 1917; January, February, March, April, May, September, 1918; February, 1919. Write with full particulars, price, etc., to Box N. Wireless Press Ltd., 12-13, Henrietta Street, Strand, W.C. 2.

TECHNICAL BOOKS. Second-hand and New Books on every conceivable subject. Catalogue free. State wants. Books sent on approval. Books bought.—FOYLE, 121/125, Charing Cross Road, London.

CHANGE OF ADDRESS.

Readers are requested to note that the address of The Wireless Press, Ltd., is now, 12 and 13, Henrietta Street, London, W.C.2.

Extra copies of the R34 chart published in this issue can be obtained from The Wireless Press, for 6d., post free.

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Company Notes.

Marconi's Wireless Telegraph Company Ltd.

REPORT OF DIRECTORS.

The Directors submit herewith the Accounts for the year ended 31st December, 1918.

The net profit for the year amounted to £597,938. 9s., which added to the balance brought forward from the last account, leaves to the credit of Profit and Loss account a sum of £974,698 14 8

From this have to be deducted the following dividends:—

On Preference Shares 7 per cent. paid on 1st February, 1919	£17,500 0 0	
On Ordinary Shares an interim dividend of 5 per cent. paid on 1st February, 1919	61,182 8 0	
		78,682 8 0
Leaving available for distribution a balance of		896,016 6 8
The Directors recommend payment of further dividends:—		
On Ordinary Shares 20 per cent. for the year ended 31st December, 1918 (making 25 per cent. for the year) ...	£244,729 12 0	
On Preference Shares 15 per cent. for the year ended 31st December, 1918 (making 22 per cent. for the year) ...	37,500 0 0	
		282,229 12 0
Leaving a balance of		613,786 14 8
Of which it is proposed to transfer to General Reserve		150,000 0 0
And to carry forward to next account		£463,786 14 8

The General Reserve will then stand at £1,250,000.

There having been no settlement with any of the Government Departments in respect of any of the Company's claims arising out of the war or for services rendered during the war, no sum in respect of any of these claims figures in the year's accounts.

Following the usual custom, the Shares in Associated Companies and Patents are taken into account in the Balance Sheet at their cost price, viz., £1,365,109. 10s. 1d. The par value of the shares now stands at £2,345,965. 12s. 3d., exclusive of shares which have no capital denomination.

The Directors regret to record the death on 9th May last, of Mr. Henry Spearman Saunders, who had been a Director of the Company since April, 1899.

Since the last Ordinary General Meeting, Mr. Sidney St. J. Steadman and Sir Charles J. Stewart, K.B.E., have been appointed Directors of the Company. In accordance with Article 74 these gentlemen retire, and being eligible offer themselves for re-election.

The Directors retiring by rotation are Mr. William Walter Bradfield, Mr. Maurice Alfred Bramston, and Mr Samuel Geoghegan, who being eligible, offer themselves for re-election.

The Auditors, Messrs. Cooper Brothers & Co., also retire, and offer themselves for re-appointment.

By order of the Board,
H. W. CORBY,
Secretary

MARCONI HOUSE,
STRAND, LONDON, W.C.2.
24th July, 1919.

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MARCONI'S WIRELESS TELEGRAPHY COMPANY LIMITED.

BALANCE SHEET, 31st December, 1918.

Dr.	£ s. d.	£ s. d.	Cr.	£ s. d.	£ s. d.
To Capital—			By Cash at Bankers and in Hand		155,070 4 9
Authorised—			By Investments, Fixed Deposit and Temporary Loans against Securities		821,371 17 10
1,250,000 Ordinary Shares of £1 each £1,250,000 0 0			By Sundry Debtors, Debit Balances and Expenditure on Foreign Developments		1,246,171 7 11
250,000 7 per cent. Cumulative Participating Preference Shares of £1 each 250,000 0 0			By Stock at Cost or Under as certified by Officers of the Company		362,796 18 2
£1,500,000 0 0			By Freehold Works at Dalston 37,789 7 11		
Issued—			*Deduct* Mortgage 9,611 12 4		28,177 15 7
1,223,648 Ordinary Shares, fully paid 1,223,648 0 0			By Freehold Property, Plant, Machinery and Buildings at Chelmsford and Genoa		129,684 13 2
250,000 Preference Shares, fully paid 250,000 0 0	1,473,648 0 0		By Long Distance Stations in England and Ireland (including Stores) and Movable Plant at other Places		102,474 13 11
To Bills Payable	4,909 8 10		By Expenditure on Leasehold Premises, Office Furniture and Fittings, London, Chelmsford and Foreign Agencies		31,600 6 5
To Sundry Creditors	328,519 15 1		By Shares in Associated Companies and Patents		1,365,109 10 1
To Reserve for Expenses Unpaid and Receipts in Advance and other Credit Balances	360,681 9 3		Shares held in Associated Companies are of a par value of £2,345,605 12s. 3d.		
To General Reserve Account	1,100,000 0 0		SIDNEY St. J. STEADMAN, *Director.*		
To Profit and Loss Account—			H. RIALL SANKEY, *Director.*		
Balance brought forward 576,760 5 8					
Profit for the year as per Account 597,938 9 0	974,698 14 8				
To Contingent Liability on Shares in Associated Companies £57,862 10s. and Liabilities under Agreements.					
	£4,242,457 7 10				£4,242,457 7 10

PROFIT AND LOSS ACCOUNT for the year ending 31st December, 1918.

Dr.	£ s. d.	Cr.	£ s. d.
To Rents, Rates, Income and other Taxes, Travelling, Publicity, General Expenses and War Subscriptions	32,278 8 7	By Balance of Contracts, Sales and Trading Account	765,069 12 5
To Salaries, Contribution to Staff Superannuation Fund and Directors' Remuneration	94,416 12 11	By Transfer, Share Warrant and other Fees	563 6 0
To Law Charges, Professional Fees and Patent Expenses	20,999 0 4		
To Depreciation of Plant, Machinery, Buildings and Furniture	18,461 0 0		
To Station Expenses	2,169 7 7		
To Balance being Profit for the year carried to Balance Sheet	597,938 9 0		
	£766,262 18 5		£766,262 18 5

We have audited the above Balance Sheet with the books in London and accounts from Rome. A large part of the Investments and Shares in Associated Companies are held abroad. Except as to a part held in Russia we have seen letters or certificates stating that they are held on behalf of this Company. We have obtained all the information and explanations we have required. In our opinion such Balance Sheet is properly drawn up so as to exhibit a true and correct view of the state of the Company's affairs according to the best of our information and the explanations given to us and as shown by the books of the Company.

LONDON, *24th July*, 1919.

COOPER BROTHERS & CO., *Chartered Accountants.* } *Auditors.*

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MARCONI'S WIRELESS TELEGRAPH COMPANY, LIMITED.

The Report of the Twenty-second Ordinary General Meeting.

The TWENTY-SECOND ORDINARY GENERAL MEETING of Marconi's Wireless Telegraph Company (Limited) was held on Aug. 8th at the Savoy Hotel, MR. GODFREY C. ISAACS, the deputy chairman and managing director, presiding. On entering the meeting room Senatore Marconi, Mr. Isaacs, and the other members of the board were loudly cheered.

The CHAIRMAN.—Ladies and gentlemen, the war is at an end, but the duties and responsibilities of some have not yet ceased. Among that number is our illustrious chairman. Senatore Marconi, who is a peace delegate at the Paris Conference, is obliged today to attend this meeting in his personal capacity evincing the interest he has always shown in this company, and it therefore devolves upon me in such circumstances to preside. I now call upon the secretary to read the notice convening the meeting and the report of the auditors.

THE SECRETARY (Mr. H. W. Corby) accordingly read the notice and the report of Messrs. Cooper Brothers and Co., chartered accountants, appended to the balance-sheet.

The CHAIRMAN.—Ladies and gentlemen, with your approval I propose to waive the formality of reading the report and accounts. The balance-sheet and profit and loss account are before you and I will deal with the figures in so far as they call for comment.

THE BALANCE-SHEET: RESERVE ACCCOUNT INCREASED.

Turning, in the first instance, to the balance-sheet, the capital account is unchanged. The bills payable are represented by a reduced figure: the amount due to creditors is, in round figures, about £100,000 higher than it was at the end of 1917, due to the business in hand at the end of the year; and the same remarks apply to the next item, which largely represents amounts received on account in respect of contracts in hand, but uncompleted at the end of the financial year. The reserve account shows an increase of £100,000 in keeping with the resolutions passed at the last general meeting. On the credit side, cash at bankers, investments, moneys on deposit, and temporary loans show such increases as might be expected from the substantial profits resulting from the last year's trading. The sundry debtors, &c., is largely consistent with the bigger figures with which we are dealing. The stock on hand has increased by some £120,000, resulting from the considerable orders in course of fiulfilment when the accounts were closed. Freehold property at Dalston is increased by reason of the annual payment in reduction of mortgage under the terms of the mortgage agreement. Freehold property shows some increase after writing off the usual allowance for depreciation in consequence mainly of additional buildings having been erected at our Chelmsford works. The amount to the credit of long-distance stations is reduced by the usual writing off for depreciation; and the next item shows a small increase in consequence of some additions due to expansion of the business.

Shares in associated companies and patents figure, as usual, at cost, and at the end of the year showed a decrease of some £130,000 in round figures. The par value, exclusive of shares which have no capital denomination, showed a reduction of £320,000. These changes are due principally to the fact that we sold, by agreement, during the last year, the whole of our assets in the Compagnie Universelle de Télégraphie et de Téléphonie sans Fil to a new French company; the Compagnie Universelle went into liquidation and at the end of the year we had not taken up our holding in this new company. I shall have more to say about this transaction later and deal with it now only to explain in considerable part the reason for the reduction in the figures in the shares held in associated companies. The sum of £1,365,000 figuring in the balance-sheet at cost and as an asset should, I think, be accompanied by some information which will satisfy shareholders that the asset is a sound one. Were it expedient to give full particulars of the shares which we hold there is no doubt that no further information would be necessary, but it would be inconvenient to give this information in all cases, and therefore it is best to give none. It would, perhaps, suffice if I tell you that the figures at the present moment represent a par value of £2,587,070, at a cost of £1,713,800, and if we take our holding in the Marconi International Marine Communication Company and the Marconi Wireless Telegraph Company of America alone, at their respective quoted values, we exceed the figure which is represented to-day as being the cost of the whole of our shares in associated companies and of our patents. (Cheers). The cost of our patents, it may interest our shareholders to know, stands in our books at £80,500.

THE PROFIT AND LOSS ACCOUNT: THE DIVIDENDS.

Turning now to the profit and loss account, the balance of contract sales and trading account amounts for the past year to £765,000, or some £220,000 more than for

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the preceding year, and the net profit amounts to nearly £598,000, which is approximately £215,000 more than in 1917. Adding the balance brought forward, £376,000, we have available to the credit of profit and loss account £974,000. We have already paid 7 per cent. on the Preference shares and an interim dividend of 5 per cent. on the Ordinary shares, and subject to your passing the resolution which we shall submit to you later, we propose to pay a final dividend of 20 per cent. upon the Ordinary shares and 15 per cent. upon the Preference shares, to transfer to general reserve the sum of £150,000, and to carry to next account the sum of £463,786 14s. 8d. I think I should tell you, by the way, that we do not think this sum is subject to any excess profits duty in consequence of the profit made in the year 1912 and the substantial increase in capital which has taken place since that date.

I think these figures will be regarded by you as highly satisfactory. (Cheers). Together with the results of the previous years they clearly demonstrate the growth of our organization throughout the world, notwithstanding the fact that it has been extremely difficult to conduct a commercial business such as ours during a period of war. There is no doubt that whilst we have benefited from the war in some respects, our progress has been very considerably retarded in other directions, particularly in the development of foreign telegraph services. Now that peace is officially restored we have a great work in front of us, and we shall endeavour to make up for the time which we have lost.

PROGRESS OF THE AFFILIATED COMPANIES.

Our affiliated companies have been handicapped, of course, by similar conditions, but taking all things into consideration, we have not too much reason to complain.

The Marconi International Marine Communication Company, Limited, in which we have a very large holding, increased its capital in the early part of this year from £600,000 to £1,500,000, and issued to its shareholders 600,000 of the new shares at par, being one new share for every share held. This company took up the whole of the shares to which it was entitled. A dividend of 15 per cent. for the year ended December 31, 1918, has been paid upon the whole of the capital, including the new issue.

The Société Anonyme International de Télégraphie sans Fil, which, as you will remember, is the Belgian Company, the control and assets of which we seized in 1914, continued to do its business under the direction of my colleague, Captain H. Riall Sankey, C.B., and myself. In recent months, however, I am glad to say, it has been possible for the head office in Brussels to take back its child into its own keeping. Its directors have declared dividends for the years during which it was not possible for the accounts to be made up. Five per cent. has been paid in respect of the year ended December 31, 1914; 7½ per cent. for the year 1915, and 12½ per cent. for each of the years 1916, 1917, and 1918, making a total of 50 per cent. for the five years. I think you will agree that in all the circumstances this is a highly satisfactory result. (Cheers.)

In France, the Compagnie Universelle de Télégraphie et de Téléphonie sans Fil, as I have previously told you, has gone into liquidation, having sold the whole of its tangible assets to the Compagnie Générale de Télégraphie sans Fil. This company was formed at the beginning of last year with a capital of 12,500,000 francs, and may be said to control the wireless telegraph business of France and her colonies. With the approval of the French Government we subscribed for 40 per cent. of the shares, and have three representatives upon the board, of which, again, with the approval and wish of the French Government, I am one. The business of the Compagnie Générale has developed so quickly, and their orders from the French Government are so extensive, that it was found necessary to double their capital. The issue was made a few weeks back at a premium of 7½ per cent., and we have applied for and been allotted the full number of shares to which we were entitled. The Compagnie Générale paid for the period of February 5 to December 31, 1918, a dividend of 27.226 francs per 500 francs share, and 1.302 francs for each founder share. Of these founders' shares also we hold our proportion. These shares have no capital denomination.

The Compagnie Francaise Maritime et Coloniale de Télégraphie sans Fil, which hitherto has conducted the business of the French Mercantile Marine, paid for the year ended December 31, 10 francs per share of 100 francs and 93.75 francs per founder share, which also are shares without capital denomination. This company is now going into liquidation, and a new company under the auspices of the Compagnie Générale de Télégraphie san Fil has been created which takes over the whole of the French Mercantile Marine, and will be placed in the same position in France as is the Marconi International Marine Communication Company (Limited) in this country.

The Amalgamated Wireless (Australasia) (Limited) has paid a dividend of 5 per cent. for the year ended June 30, 1918.

The Marconi Wireless Telegraph Company of America paid a dividend of 5 per cent. for the year ended December 31, 1918. This was a very conservative distribution on the part of that company, but, no doubt, the directors acted with wise discretion.

THE RUSSIAN COMPANY.

The Russian Company of Wireless Telegraphs and Telephones, as you are aware, has its head office in Petrograd, and I have no reliable information to give you about this business. I had, however, the advantage of

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meeting in recent months one of the directors of that company, who had the good fortune of his journey from Russia being facilitated by those at present controlling the destinies of that great country. I can only repeat to you, for what it is worth, the information which he gave to me. He informed me that he left Petrograd in the month of May last year, when the managers of the company were well, and although business was being conducted under very difficult circumstances they were, nevertheless, extremely busy. They had received, considerable orders from the Russian Government, and to his knowledge had been paid in advance on account of those orders 1,750,000 roubles. Of course, what these roubles were, or what they are worth, or what they ever will be worth, I am not in a position to tell you.

In Norway, by arrangement with us, a Norwegian Wireless Telegraph Company has been formed; we hold a substantial interest in that company, and are represented upon the board.

FORMATION OF A COMPANY IN CHINA.

In China a company has been formed under charter notified to the British Legation. It has a nominal capital of £700,000, which is to be subscribed as and when required conjointly in equal moieties by the Chinese Government and ourselves. We pass to this company our patent rights and designs, and receive in return one-third of the profits in each year until such time as we may be paid a substantial sum of money, which sum has been agreed in satisfaction of those patent rights and designs. We are therefore entitled, meantime, by reason of our shareholding and patent rights, to two-thirds of the profits of this Chinese National Company. The company has a monopoly of the supply and maintenance of all wireless telegraph apparatus in China. (Cheers.)

There are other companies in the course of formation in other parts of the world about which I hope to be able to say more to you next year.

RECONSTRUCTION OF THE CANADIAN COMPANY.

Although the Marconi Wireless Telegraph Company of Canada has made good progress it has not yet been able to pay a dividend. We have long felt, as I think I have told you before, that some reconstruction of that company was necessary, and I am glad to be able to tell you that we have now agreed with the Canadian company that their capital, which consists of a million shares of $5 each, shall reduce its capital by halving the nominal value of the shares, making their shares $2½ each instead of $5, and that 500,000 new shares of $2½ each shall be created. An agreement has now been entered into under which we have agreed that we will purchase 400,000 of the new shares, and that the long outstanding indebtedness of the Canadian company to this company, which has always so severely handicapped the Canadian company, shall be liquidated. The company, as a result of these arrangements, have a clean sheet and a substantial working capital. Subject to the general meeting of shareholders, which is being convened at once, approving these recommendations, as I have no doubt they will, they will be promptly put into execution. There was but one thing more in our opinion to ensure the successful future of the Canadian company, and that was an able and energetic managing director with knowledge of the wireless telegraph business. I am glad to be able to inform you that we have secured such a man in Mr. Arthur H. Morse, and the Canadian directors have accepted our recommendation and appointed him managing director. Unless the departures of steamers for Canada are still held up, he should be well on his way to take up his new duties. I shall be surprised and disappointed if we do not now see a marked improvement in the development of the Canadian company. (Cheers.)

In Italy we have continued to do a substantial business under the ever-able and energetic management of the Marquis Solari. In consequence of the war, however, we have not yet received any part of the fruits of the agreement which we entered into with the Italian Government, but we may now look forward to considerable revenue accruing to us from the share to which we are entitled of the receipts from the commercial wireless services conducted by the Italian Government.

The Compania Nacional de Telegrafia sin Hilos, the Spanish company, continues to progress. Its coast stations are commencing to get busy with ship and shore messages; there is already promise of a much larger traffic than in pre-war days. The commercial service with Germany and Austria continues, and it will soon be re-opened—if it has not already been re-opened—with Italy. In the spring of this year permission was received to commence a service with this country. Neither the Spanish station nor the station at our disposal in this country proved to be altogether satisfactory for the purpose of conducting an efficient telegraph service. The first week's traffics, however, were very promising, but a telegraph operators' strike in Madrid disorganized the traffic, causing considerable delays. The service is not now being pressed pending arrangements being completed for the provision of stations which will be able to be devoted to their work without interruption.

The Argentine company since the outbreak of war has been obliged to mark time. All preparations are now being pressed forward to complete the erection of a high-power station near Buenos Aires and another in this country for the conduct of a direct telegraph service at reduced rates. The development of the science in recent years encourages us in the belief that we shall be able to offer the

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the public a rapid and reliable service at subservice at reduced rates. The development of the science in recent years encourages us in the belief that we shall be able to offer the public a rapid and reliable service at substantially reduced rates. The fact that we are able to send messages to Sydney, New South Wales, a distance of over 12,000 miles, the "record" in wireless telegraphy, from a station built to communicate 3,000 miles furnishes some indication of the progress made in recent years. (Cheers.)

The Pan-American Company, which shareholders will remember was formed for the purpose of conducting telegraph services between North and South America, are also engaged in building a station in Buenos Aires to communicate with New York.

We are awaiting the official declaration of Peace in the United States of America for the high-powered stations in the United States to be re-transferred to private ownership, when direct telegraph services will promptly be opened between Europe and New York.

We have entered into an agreement with the Colombian Government under which we shall erect a station in Bogota which will serve as a centre for other useful developments towards creating a world-wide wireless telegraphic service.

Assistance of the Foreign Office.

Ladies and gentlemen, so far I have been dealing with all our businesses and interests abroad which have been mainly responsible for the satisfactory results which appear in the accounts presented to you. We wish to acknowledge the very valuable assistance which has been afforded to us by our Foreign Office in very many of our negotiations abroad. We have never on any occasion asked for help in any part of the world without its having been given to us to the fullest extent that circumstances would allow. (Cheers.)

But I must now leave a bed of roses and deal with the more thorny aspects of our business at home.

The Company's War Services and the Postmaster-General.

I am sorry to tell you once more that we have not been able to arrive at any settlement with his Majesty's Postmaster-General in respect of the services which we have rendered during the war. I deeply regret that the Official Secrets Act and a sense of patriotism prevent my reading to you a full record of this company's services to the Empire from the very eve of the outbreak of war until the signature of Peace. It is a record, ladies and gentlemen, of which the company has every right to be proud, and which not only you, but the people of the whole Empire would warmly applaud could the book be opened. I think I have told you on previous occasions that a high official of the Admiralty had gone so far as to say that the British Navy would have been far less efficient had it not been for the Marconi Company, and he added that there was no company which had rendered greater services to the Empire than ours. (Cheers and a voice: "Bravo.") Yet we have not been able to obtain anything approaching what we deemed a reasonable offer for such of the work which we have done, and for which payment could, and should, be made.

We have asked the Post Office to pay us for the 80,000,000 words which we intercepted and reported day and night since the outbreak of war to as many sometimes as 40 different addresses directed by the Government. This work was done under the most difficult of circumstances, either under direct instructions from the Government or at the company's suggestions, made as the result of its observations of altered enemy tactics. Enemy fixed and portable stations, Naval stations comprising service ships, submarines, and aircraft, have all had to be dealt with. We designed entirely new receiving apparatus to meet the continually changing circumstances and counteract enemy activities. Some of the ablest of the company's engineers devoted their whole time to this work. The nature of the interception work, owing to the absence of facilities for calling for repetitions, was very difficult, particularly when it is borne in mind that half of the traffic was in cipher. But we were further handicapped by the absence of knowledge as to which stations would be sending messages or with what wave-lengths they would work. Yet everything was carried out to the complete satisfaction and appreciation of the Government Departments served. Upwards of 8,000,000 words were in foreign languages, including Russian, German, Italian, French and Rumanian. All these messages were translated by us and delivered to the numerous addresses designated to us by the authorities.

Since our stations were returned to us after the Armistice we have been conducting work of a somewhat similar nature, but a much simpler and easier one, for another Government Department. After consideration that Government Department fixed 3d. per word, which was what they deemed to be a reasonable rate of pay for the nature of the work which we were doing. We accepted what the Government Department considered reasonable. But for the much more difficult and onerous work which I have just described, and for which we have to look for payment to the Post Office, we have not been able to obtain an offer of more than what amounts to approximately one and one-fifth of a penny per word. (Cries of "Shame.") And this is not only offered to us as remuneration for our services, but it is to cover also compensation for our having been deprived of the use of the whole of our stations except Clifden during the whole period of the war. (Shame.) This one and one-fifth of a penny per word left but a very small margin over and above our actual out-of-pocket expendi-

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ture. We have made many attempts to arrive at a reasonable settlement, and have offered to accept terms substantially less than those which we are being paid and to which I have already referred.

We would have willingly made that sacrifice in order to ensure the good relations which it is the company's aim to maintain with all Government Departments, but all to no avail. In these circumstances, ladies and gentlemen, as painful as it is to have to sue a Government Department under Petition of Right, you will not be surprised that we have again been driven to commence new proceedings and are threatened once more with being forced into a Court of Law, expending large sums in legal costs and wasting the time of the important officials of the company, whose whole energy and time are required successfully to run the vast machinery of our world-wide organization.

THE IMPERIAL CHAIN OF WIRELESS STATIONS: THE RECENT PROCEEDINGS.

And this leads me to the proceedings which have recently terminated. I do not want to take up time now by repeating at any length the history of the contract for the Imperial Chain of Wireless Stations, but I would remind you that the trouble commenced in 1910, when we asked for a licence to build stations at our own expense, creating a wireless chain of telegraph communication throughout the Empire, which resulted in the contract of 1912. This was followed by the contract of 1913, repudiated at the end of December, 1914. Negotiations continued for years. Terms of a new contract were offered to the company in substitution of the 1913 contract by way of settlement, which the company accepted. The draft contract, however, was never forthcoming, and finally we despaired of ever arriving at a settlement, and proceedings were taken under the Petition of Right. Judgment was given in favour of the company in March, 1918. The damages had to be assessed by an arbitrator; a Judge of the High Court was appointed, conditionally upon both sides agreeing that there should be no appeal, and the award has recently been announced. The hearing lasted 18 days, during which many of us had to sit continuously in Court and commence our day's work when the Court rose. Ladies and gentlemen, when you bear in mind that the Post Office contended that the value of the contract was £47,500, or in the most favourable circumstances £50,000, you will understand why, after years of negotiation, we were obliged to have recourse to a Petition of Right.

THE CLAIM AND THE AWARD.

And now, ladies and gentlemen, before I go further, I must say a word or two as to how the claim submitted by us was compiled. After we obtained judgment we were desirous of going before the arbitrator and placing all facts and figures before him, leaving it to him to award us a *quantum meruit*. The Post Office, however, said "No! You must define your claim." This it was impossible for us to do other than by a formula, in symbols, embracing all the conditions of the contract, subject to its being interpreted in the most favourable manner possible to us, and such estimates of percentages of traffics and traffic increases as we thought we might reasonably suppose might take place in the course of 28 years, the longest term provided by the contract. At best, of course, this formula could only be based upon hypothesis, and we had of necessity to claim all that was possible in the most favourable circumstances. This, however, did not satisfy the Post Office, and again they pressed for actual figures, but without the knowledge of the cable traffics we could supply no figures. Finally, however, the Post Office agreed to furnish us with the actual cable traffics. To these figures we merely applied our formula, as we were obliged to do, and it worked out to the large figure of the claim. We had no alternative but to submit this account, but we submitted it very reluctantly. It was, however, impossible for anybody to say that over the 28 years, had the contract been carried out, even this figure might not have been justified.

THE POST OFFICE DEFENCE.

When we came into Court, and without having given us any previous intimation, the Post Office set up the defence—

(1) That between 1914 and 1919, even had the stations been erected, we should have been entitled to no royalties, because, they said, they would not have been allowed to conduct a commercial service during the war. As to whether this is true or not I leave it to you to form an opinion. You will take into consideration the fact that the cables were in a most congested condition—the whole country was crying out about the delay in the transmission of cable messages; that we as a private company were allowed to conduct commercial services at Clifden until some months after America entered the war; that this service was only stopped at the instance of the United States Government; and I do not think you will find it difficult to draw your own conclusions.

(2) The Post Office contended that subsequent to 1919 all the essential Marconi patents would have expired, and they could then conduct a service without any of the latter improvements which the company might introduce, or desire to introduce, and would consequently cease to pay any royalties to the company. I should say here, in parentheses, that this contention, if it stood alone, was ample justification for the mistrust which my company had expressed on the manner in which the Post Office intended to carry out the contract (hear, hear), for Mr. Herbert Samuel, when he obtained from us some modifications of the terms of the contract in 1913, had said that his object was to give

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the country the benefit of some epoch-making invention should occasion arise. Every improvement or invention has emanated from or belongs to the Marconi Company, and some of these are certainly epoch-making. (Cheers.)

And, thirdly, the Post Office put forward this extraordinary proposition:—That the wireless chain of stations could never have secured the traffics for which the contract made provision and the Marconi Company anticipated for had it done so the cable companies would have suffered, and the Post Office would have increased the wireless tariffs in order to protect the cable companies. (Laughter.) Would that have been an honourable procedure towards the Marconi Company? And what about the public and the all-important industrial interests of the Empire? They mattered nothing to the Post Office. Their first duty, they think, is to protect the cable companies.

THE WITNESS CALLED BY THE POST OFFICE.

And now I must tell you something about the way in which the Post Office endeavoured to improve its eleventh-hour case. They called an engineer who had been in the employ of the Poulsen Company. He prepared overnight a specification which it was contended would enable the Post Office to construct stations without using any unexpired Marconi patents. The specification and the blue print which were produced proved the reverse. It is true that they provided for transmission by a Poulsen arc under the first Poulsen patent, which expired last year, but the rest was Marconi, except that they could avoid interference, it was contended, by using a secret Admiralty patent, which their witness swore the Admiralty had used most successfully for this purpose since 1905. He was an Admiralty expert, and said that he knew of nothing so efficient for its purpose. This contention was very serious, and had it succeeded might have cost our company over £600,000. I ask your particular attention to what it turned out to be. After some trouble our counsel succeeded in forcing the consent to break the seals of this secret patent. It proved to be identical with the provisional patent applied for by the Marconi Company in 1903. The witness who produced the secret patent and swore to its efficiency was in the company's employ in 1903. He was recommended by the company to the Admiralty, in response to a request, and entered Admiralty service at the end of 1903. He stated that he had communicated the invention comprised in our 1903 application to the Admiralty in conformity with the agreement which entitled the Admiralty confidentially to receive information as to the company's inventions. It happens that the witness had himself been one of the signatories to the company's provisional application in 1903—a fact, he said, he had forgotten. This provisional application, after full trial and tests by our experts, proved to be valueless, and not worth a final specification at a cost of a £5 note. (Laughter.) So much for the valuable secret patent. The Judge said that the calling of this witness was a sheer waste of time. (Hear, hear.)

There are two other incidents of imporance which I think it my duty to place before you. The Post Office, who put forward the contention that they could use a Poulsen arc for transmission for the Empire chain of stations, and could otherwise do without Marconi patents, desired to call a French Government witness to give evidence to that effect. A step better calculated to ruin the Marconi Company at home and abroad, had it succeeded, it would be difficult to conceive. The first step towards obtaining the French Government's assistance was taken by a member of Parliament who was primarily responsible for the delay in the construction of the Imperial chain of stations in 1912. You, ladies and gentlemen, may wonder why. And you may ask yourselves through whom and in what way is this gentleman associated with the General Post Office. The French Government with courtesy could not refuse to send over the officer in charge of the Eiffel Tower Station to give evidence. The Post Office witness—the Post Office representative—said he interviewed him, but he was not called as a witness. I will tell you why. He would not give the evidence the Post Office required of him; he would have disproved the Post Office's case; he was here for three days, and returned to Paris; but, nothing daunted, the Post Office persisted in its contention.

FRENCH OFFICIAL EVIDENCE.

We, fortunately, had private knowledge of this incident, and we called French official evidence. This proved (1) that the French Government had considerable experience of long-distance telegraphy; (2) that Poulsen arcs had proved a failure for commercial wireless telegraphy; (3) that the Poulsen arcs were being superseded in French stations by up-to-date inventions, which had proved to be far more efficient; (4) that the French Government could not build stations for commercial purposes without using the patents of the French company; (5) that the French company had the right of use of the Marconi Company's patents and the Marconi Company owned the British rights of all the French company's patents. (Loud cheers.) Ladies and gentlemen, the Post Office completely failed to make out their case. Their own witness, Mr. Swinburn, an eminent scientific expert, said that the Marconi Company had made great improvements in wireless telegraphy in recent years, and still led the world in the development of the art—their own witness, an independent expert witness. (Cheers.)

Mr. Justice Lawrence, in giving his award, said that it represented the full royalty which he thought the company would have received during the full term of 28 years specified by

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the contract. This meant, after hearing all this evidence, that the learned Judge was satisfied that: (1) the specification submitted by the Post Office would not render the erection of the stations possible without using Marconi patents; (2) that the Poulsen arcs would not provide an efficient form of transmission for the purpose required; and that (3) the Post Office would have required to use Marconi patents for internal and external transmission and internal and external reception.

AFTER THE AWARD.

Ladies and gentlemen, if the Post Office and the company had failed to arrive at an agreement in consequence of a genuine divergence of opinion as to the value of the contract, one might have hoped and expected that the learned Judge's award would have opened the way to a simple and straightforward course in the interests of the country. One might have thought that the Post Office would have said to the company, "Now that this matter is settled, and the value of the contract has been defined, the Imperial chain of stations has to be built as quickly as possible; the country must have the benefit of your inventions, your experience, and the £60,000 a year which you spend upon research. We do not want to throw away £600,000 of public money for nothing; let us make another attempt to arrive at an agreement which will avoid the loss of this large sum of money and give to the company a reasonable equivalent in its place." It was known to the Post Office that we had again offered to build the Imperial chain of stations at our own expense, as we had offered to do in 1910; that we had suggested, if Government control were still deemed necessary, an arrangement could be come to with the company by which this could be achieved, without losing the advantages of the stations being built and worked by private enterprise. The Post Office took no such course. They went to Parliament for a supplementary vote of £170,000, and the following morning caused an inspired announcement to appear in the *Daily Mail* to the following effect:—"The Post Office engineers are installing a system which they say is free of all existing Marconi patents, and no royalties will be payable to the Marconi Company." Ladies and gentlemen, I say without hesitation that this cannot be done (hear, hear); and after the hearing before Mr. Justice Lawrence the Post Office must know that it cannot be done. (Loud cheers.)

THE "PROGRAMME" OF THE POST OFFICE.

What is it that they are proposing? Let us examine their programme. They say, "For transmission we will erect Poulsen arcs, the original patent of which expired last year. The French Government say, We have tried this; it is a failure. We are pulling out the Poulsen arcs. But that does not matter; we, the Post Office, will avoid paying Marconi royalties at any cost. For reception we will use the expired Marconi patents. For avoiding interference we will employ the Admiralty secret patent—an abandoned Marconi invention of 1903." The Post Office engineers admitted that they knew little or nothing about the long-distance wireless telegraphy and had had no experience of it. They are going to start building the Imperial stations by experimenting with obsolete systems. What matters it to them that they throw away £600,000 of public money; that they delay the provision of an efficient Imperial chain of stations for another nine years; that the supplementary vote of £170,000 and further large sums be spent to no purpose; that other nations are contracting for the construction of stations embracing all the important scientific improvements discovered up to the latest moment? The art as it was known in 1904 is good enough, the Post Office thinks, for the British Empire. Will the British public think so? Will this watertight Government Department be allowed to adopt this suicidal policy, and, in its ineptitude, raise the price of telegrams to cover its failure, as it is proposing to raise the price of telephones? The Chinese, under recommendation of the British Foreign Office, are to have the benefit of the latest Marconi inventions, and of their research work year by year. The British Post Office will have none of it; what the company did 14 years ago will do for them, and they will pay no royalties to the Marconi Company.

"THE CRUX OF THE WHOLE QUESTION."

That is the *crux* of the whole question—no royalties to the Marconi Company—and why? What has been the crime of the Marconi Company? When war broke out they placed their whole resources at the disposal of the country. They have rendered services surpassed by none. The stations being badly needed, self-interest was forgotten; the country's need came first, and they offered in September, 1914, to waive their royalties and build the Imperial stations, leaving it to the Government to pay them whatever they thought fit. The Post Office declined. In November, 1914, the company again offered to waive their royalties and to build the stations for a fixed price, which would have left them a profit far less than the amount of the recent award. The Post Office declined; they repudiated instead. In 1916 the company accepted the Government's offer to build the stations upon terms far less favourable to them than those of the 1913 contract. The draft contract was to be submitted by the Government immediately; it was never forthcoming. In 1917 and 1918 they again negotiated and endeavoured to agree to terms for another substitued contract. They could not agree; how could they? The Post Office valued the old contract at £47,500. The Arbitrator, one of his Majesty's Judges, says it was worth £1,200,000, or, reduced to a cash payment on December 31, 1918,

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£590,000—equivalent to £606,000, approximately, in cash at the present time.

To-day we are again willing to negotiate, but the Post Office says, "The country shall lose its £600,000; it shall have worthless, obsolete stations, built by inexperienced Post Office engineers, but we will tell all the foreign Governments, your customers, that the British Post Office can do without Marconi patents; no royalties will be payable to the Marconi Company." "This marks a revolution in wireless services," the *Daily Mail* is caused to say.

A Demand.

Ladies and gentlemen, is not all the sufficiently conclusive evidence that a genuine divergence of opinion was not the cause of our failing to arrive at an agreement? Is it not clear that there is something else behind this inexplicable conduct of the Post Office? (Cheers.) I say emphatically that had the Post Office wanted to arrive at an agreement there would have been no petition of right, there would have been no arbitration, and there would have been no award. Their conduct and attitude ever since Mr. Herbert Samuel left office have been inexplicable, and have resulted in a great waste of public money. I demand that before more money is squandered upon the Imperial stations an inquiry be held to investigate the extraordinary procedure of the Post Office and elicit on whose guilty shoulders lies the responsibility for their attitude with regard to the Imperial chain of stations. (Loud cheers.) I may speak with feeling—I do speak with feeling—for should personal enmity of an individual at the Post Office exist against any individual of this company, I say emphatically that he is failing in the sacred trust he holds in allowing his animus to stand in the way of the interests of the country. (Hear, hear.) There is something rotten in the state of the Post Office which demands investigation. (Hear, hear.)

The war being over we now hope to arrive at settlements with the Admiralty, the War Office, and the Air Ministry in respect of the extensive use which has been made by each of them of many of our patents; but before we can proceed we have to await an arbitration, as agreed, with the Admiralty, in respect of the Lodge patent, which must be disposed of before it is possible to deal with matters as a whole. I trust it may be possible to dispose of all of them by the end of the year. It is a curious and significant fact that, although we have met with so much trouble in our relations with the Post Office, the relations we have throughout had with all the other Government Departments remain to-day, as they have always been, entirely satisfactory. (Cheers.)

Important Discoveries.

Very important discoveries have been made in respect of both wireless telegraphy and telephony in recent times, for which a number of new patents have been taken out and applied for. They are likely to have far-reaching consequences, the effect of which it is impossible at present to foretell. We have a number of the ablest and most experienced men in wireless telegraphy continuously engaged in research and experimental work, which more than justifies the very large annual expenditure which we devote to this important branch of our organization.

Ladies and gentlemen, the amount of the award was received on Tuesday last. In view of what I have said to you, we do not at present propose to touch it; we propose to wait a little. We shall have to call you together again ere long to consider some increase of our capital. We have considerable developments in view, for which provision must be made; there may be more within the next few weeks. We require a little more time for consideration. We may know better where we stand when we meet you again in the autumn.

The Joint General Managers.

Ladies and gentlemen, since we met last year, Mr. Henry William Allen has, at my request, resigned the secretaryship of the company. He held that position since the company was incorporated over 22 years ago. Some of you who are old shareholders may know what signal service he has rendered during all those years and how deeply we are all indebted to him. (Cheers.) Last year I had the pleasure of informing you that he and our manager, Mr. Walter William Bradfield, C.B.E., had been appointed members of the board; to-day I have pleasure in announcing that these two gentlemen have accepted the positions of joint general managers of the company. (Cheers.)

I regret to have to inform you of the loss which we have suffered recently by the death of Mr. Henry Spearman Saunders, who had been a director of the company since 1899.

New Directors.

I have to inform you that Sir Charles Stewart, K.B.E., who is known to all of you in connexion with the very important position which he has held for many years as Public Trustee, and Mr. Sidney St. J. Steadman have joined our board, and we look to them with great confidence to render us substantial assistance in the efficient discharge of the responsibilities which we carry in the conduct of this business. (Cheers). Further, I have to inform you that the many members of our staff who joined the Services, or in other capacities were lent to the Government for the period of the war, have returned, or are returning, to their positions in the company. We owe to them, as we owe also to all those who were allowed to continue with the company to fulfil equally important duties, a warm recognition of all the valuable services they have rendered both to the company and to the country. (Cheers.)

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Ladies and gentlemen, I have endeavoured to put before you all the important matters with which we have to deal as fully and at such length as I have thought necessary. I hope I have not detained you too long; if I have omitted anything, or if there is any further information required, I will answer any questions which shareholders may wish to put to me before formally moving the first resolution. (Loud cheers.)

Are there any questions, ladies and gentlemen? No one rising to speak, the CHAIRMAN, continuing, said:—Well, there being no questions, I will formally move, "That the report of the directors submitted, together with the annexed statement of the company's accounts at December 31, 1918, duly audited, be received, approved and adopted," and I will ask Captain Sankey to second it.

CAPTAIN H. RIALL SANKEY, C.B., R.E. (Retired)—Ladies and gentlemen, I beg to second the motion.

The motion was put to the meeting and carried unanimously.

Mr. HENRY W. ALLEN, F.C.I.S.—I have pleasure in moving, "That a final dividend of 20 per cent., equal to 4s. per share, less income-tax, upon the Ordinary shares, now issued and paid up, be and the same is hereby declared for the year ended December 31, 1918; that a final dividend of 15 per cent., equal to 3s. per share, less income-tax, upon the Cumulative Participating Preference Shares be and the same is hereby declared for the year ended December 31, 1918; that the said dividends be payable on August 25, 1919, to shareholders now registered on the books of the company and to holders of share warrants to bearer."

Mr. W. W. BRADFIELD, C.B.E.—I have pleasure in seconding that.

The resolution was unanimously passed.

PROPOSED PRESENTATION TO SENATORE MARCONI AND MR. GODFREY ISAACS.

Mr. MAURICE A. BRAMSTON.—Mr. Chairman, ladies, and gentlemen, I will ask your permission to make a suggestion. I am not at all sure that Senatore Marconi, or Mr. Godfrey Isaacs—who have received no hint of my intention—will approve of my action, but I have some confidence that it will not be opposed by the shareholders on the other side of the table. Senatore Marconi is, as you know, the genius who has invented and perfected the system which bears his name. To his unremitting work the success of our company, so far as the technical side is concerned, is principally due. His world-wide reputation is of the highest, and he stands on a level with, if he does not excel, Edison and the greatest inventors of our time. (Cheers.) He has been a great benefactor to mankind—(hear, hear)—and we are all greatly honoured by our association with him. But although his business abilities are of no mean order, I do not think he could alone have achieved for the company such a supreme commercial position without assistance. Some nine or ten years ago he was fortunate enough to secure the co-operation of Mr. Godfrey Isaacs, and both the Senatore and the shareholders are to be congratulated on the selection. Mr. Godfrey Isaacs has had a very strenuous year. (Hear, hear.) I venture to think that the magnificent position in which our company stands to-day is to be attributed in a large measure to his activities. (Hear, hear.) Of his brilliant abilities you are all aware, but those on the other side of this table do not perhaps know the infinite pains he takes in his work, of his great powers of organization and of his indefatigability. The suggestion I have to put before you is that you should recognize in a substantial way the services of the Senatore and of Mr. Godfrey Isaacs, and that you should authorize that their portraits should be painted at the expense of the company and placed in a suitable position at Marconi House. (Cheers.) I also suggest that replicas of the pictures should be presented to them for their respective homes. (Hear, hear.) The resolution which I have the pleasure and honour to propose is, "That full length portraits of Senatore Marconi and Mr. Godfrey Isaacs be painted at the expense of the company and placed in a suitable position at Marconi House, and that replicas of the portraits be presented to them in recognition of their invaluable services to the company." (Cheers.) I hope that some shareholder on the other side of the table will be good enough to second the resolution.

Mr. BALFOUR ALLEN.—I have great pleasure, indeed, in seconding the resolution which has just been proposed. I shall not detain you by adding anything to what the director has said as to the eminent services of Senatore Marconi and Mr. Godfrey Isaacs. I second the resolution.

Mr. MURRAY GRIFFITH.—As I have had the privilege for many years of counting among my friends Senatore Marconi and Mr. Godfrey Isaacs, it affords me great pleasure—I cannot say to second the resolution, as that has been already done—but of supporting it and of voicing the views of the shareholders on this side of the table. A mere portrait cannot convey to the shareholders, perhaps, the personality which surrounds our managing director. It is almost impossible for us here in this room to realize the extraordinary energy which he puts, and always has put, into his wonderful work for this company. Not only will the gift of a portrait come from you as an expression of your appreciation of Senatore Marconi and Mr. Godfrey Isaacs, but there are thousands of homes in England at this present moment who think with gratitude of the messages which have been flashed by your company and which have saved many and many a life, and, incidentally, many thousands of pounds. I am sure that we on this side of the table endorse every word that has come from the proposer of the resolution. The words of comfort which Mr. Godfrey

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Isaacs has uttered are very satisfactory. When one read the statement in the *Daily Mail*, I must say for myself that I thought the whole of the organization was already done, but organization is a great thing. We have not only the invention, but we have also the organization. I have had some little experience with Government Departments, and I know that it takes times to perfect an organization, and it takes brains, too. (Hear, hear.) I do not wish to detain you, ladies and gentlemen. I am sure that the resolution meets with our heartiest approbation. Mr. Godfrey Isaacs does not require his personality to be spread in his family and amongst those who know him, but there will come a day when he will not be here; I feel sure, however, that the day will never come when his relations with the Marconi Company will be forgotten. (Hear, hear.) It will then be pleasant to his family to look back and think that the shareholders desired to show their appreciation of his services and to perpetuate his memory.

The resolution was unanimously carried.

The CHAIRMAN.—On behalf of Senatore Marconi and on my own behalf, I thank you very sincerely indeed, ladies and gentlemen, and I also thank my colleagues for this very thoughtful and very kind mark of appreciation, which I am sure Senatore Marconi and I will receive with the greatest possible satisfaction. Speaking for myself, and it is probable I am speaking very much as Senatore Marconi would speak, I have not been consulted about this. I have heard nothing about it until now, and it came to me as an utter surprise. Had I been consulted, I am afraid I should have had to tell my colleagues, as I tell you, that there is little probability of that portrait ever being painted, for I do not know whether any painter will have the patience to come to my office to paint me, and I shall certainly never have the time to go to him. But, however that may be, the kind thought and feeling on the part of both directors and shareholders will be ever present in my mind. Now, ladies and gentlemen, we must proceed with our work, for I am sure we are taking up more time than busy men can afford. I will therefore move: "That the directors, Mr. Sidney St. J. Steadman and Sir Charles J. Stewart, K.B.E., who retire in accordance with Article 74, as altered by special resolution, be re-elected directors of the company. That Mr. William Walter Bradfield, Mr. Maurice Alfred Bramston, and Mr. Samuel Geoghegan, who retire in accordance with Article 81, be re-elected directors of the company."

Mr. ALFONSO MARCONI.—I have very much pleasure in seconding that motion.

The motion was unanimously agreed to.

On the proposition of Mr. CROFT, seconded by Mr. CLAY, it was then resolved: "That Messrs. Cooper Brothers and Co. be re-elected auditors for the ensuing year, and that their remuneration for auditing the accounts to December 31, 1918, be 700 guineas."

ALTERATION OF ARTICLES.

The CHAIRMAN.—Ladies and gentlemen, that, I think, concludes the business of the ordinary general meeting. The extraordinary general meeting is a very simple matter. We have had the number of our directors limited to 10 by our Articles since the company was incorporated. I need not remind you that the company to-day is a very different concern from what it was then. We all feel that we require some additional aid, and therefore it is that we put this resolution before you to give us power to elect two further gentlemen to our board, and in doing that we ask you if you will agree that our remuneration as directors shall not be curtailed on that account, but that the total remuneration of the directors shall be increased in proportion to the amount of the fees of the two additional directors. I do not want there to be any misunderstanding in submitting this resolution. We are not asking for any additional remuneration; we are only asking you not to take away from us any of our present remuneration and give it to the two new directors, but that you should increase the remuneration so as to provide them with the same amount of fees as we ourselves are at present receiving. I now move:—"That the Articles of Association of the company be altered in the following manner:—

"(a) By submitting the following article for Article 72, that is to say:—

"'72. The number of the directors shall not be less than five nor more than 12, but the directors may act notwithstanding any vacancy in their body.'"

"(b) By substituting the following article for Article 77, that is to say:—

"'77. The remuneration of the directors shall, as from the 1st day of January, 1919, be at the rate of £5,000 per annum, and in addition thereto in any year in which the dividend or dividends and / or bonus declared and paid for such year on the Ordinary shares of the company shall be in excess of £7 per cent. on the nominal value of such shares, the remuneration of the directors shall be increased by the sum of £250 in respect of each 1 per cent. paid by way of dividend and / or bonus on the Ordinary shares in excess of £7 per cent. as aforesaid. The remuneration of the directors shall be divided between the directors in such proportions as they may from time to time determine."

Mr. S. ST. J. STEADMAN.—I shall be happy to second that.

The resolution having been put to the meeting and carried unanimously, the proceedings terminated.

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THE
WIRELESS WORLD

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OCTOBER,
1919

Wireless Telegraphy at Archangel

An Account of the Station and Conditions Encountered.

By R. K. Rice, A.M.I.E.E.

IN the latter part of 1918 the construction of a medium power station for communication between General Ironside's Forces at Archangel and the British Isles and Admiral Koltchak's troops in Siberia was commenced to the order of the War Office.

Cable communication had been interrupted in November and as the fault had been located in or around a mine-field there was some urgency in establishing direct wireless communication. The distance between Aberdeen and Archangel is approximately 1,300 miles and for this purpose a 25-k.w. Marconi Arc Set employing two 305-ft. sectional steel masts (Gray pattern) 600 ft. apart, was designed and supplied. The completed set comprises a 50-h.p. Diesel Oil Engine belt coupled to a 30-k.w. Crompton d.c. generator delivering 350/600 volts. The arc may be run directly off the generator or off a 600-ampere-hour Chloride battery of 200 units. A motor-generator set capable of supplying 110 volts is used to feed the auxiliary circuits and for lighting purposes. Our photograph shows the engine, dynamo, motor-generator set and the main switchboard controlling battery charge, aerial heating and auxiliary circuits. To the right may be seen a Lister 3-k.w. self-contained lighting set used for charging small accumulators for receivers and for various other purposes.

The gear is housed in a wooden building some 150 feet long by 38 feet wide, having an inner and outer lining separated 6 inches apart. The roof is covered with felt and all windows are double. Three large wood-burning stoves of Russian pattern are used for heating the whole building. The building comprises accumulator, engine, transmitting and receiving rooms and an office for the Engineer-in-Charge. All floors are of wood with the exception of the engine room which is concreted. The tanks for the water cooling of the engine are housed inside the building.

Owing to the presumed absence of sand and stone for concreting some 300 tons were shipped from England and great precaution had to be taken whilst laying the engine room floor in heating

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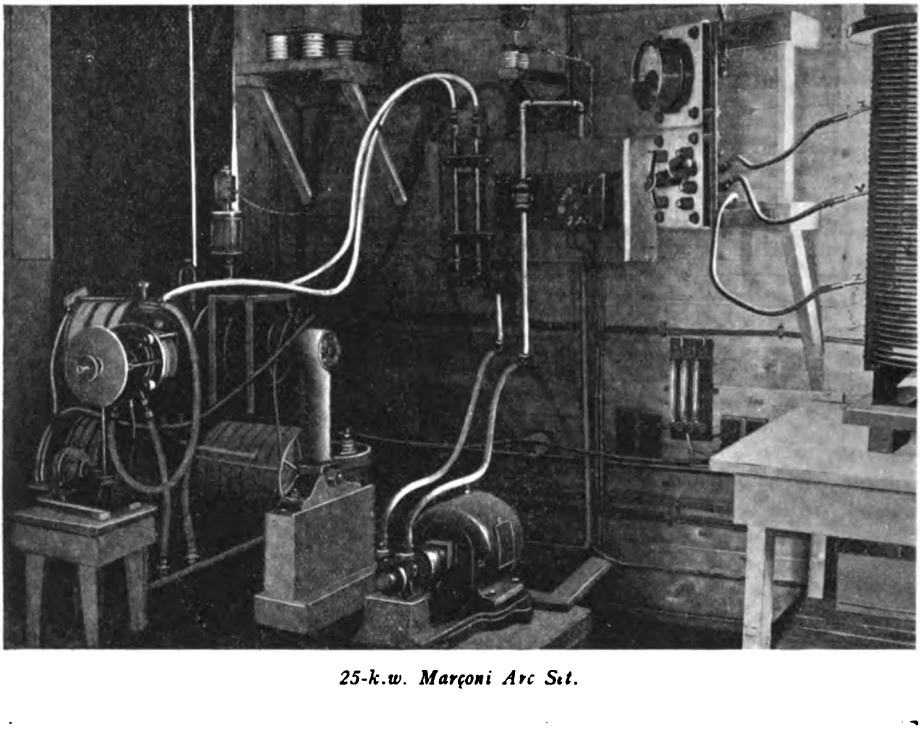
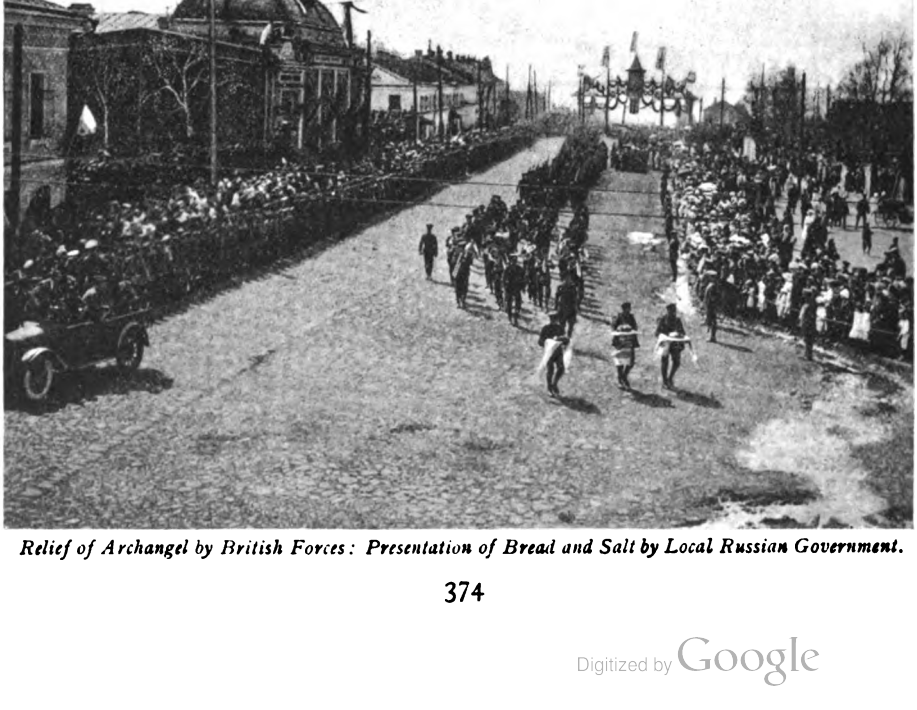


25-k.w. Marçoni Arc Set.



Relief of Archangel by British Forces: Presentation of Bread and Salt by Local Russian Government.

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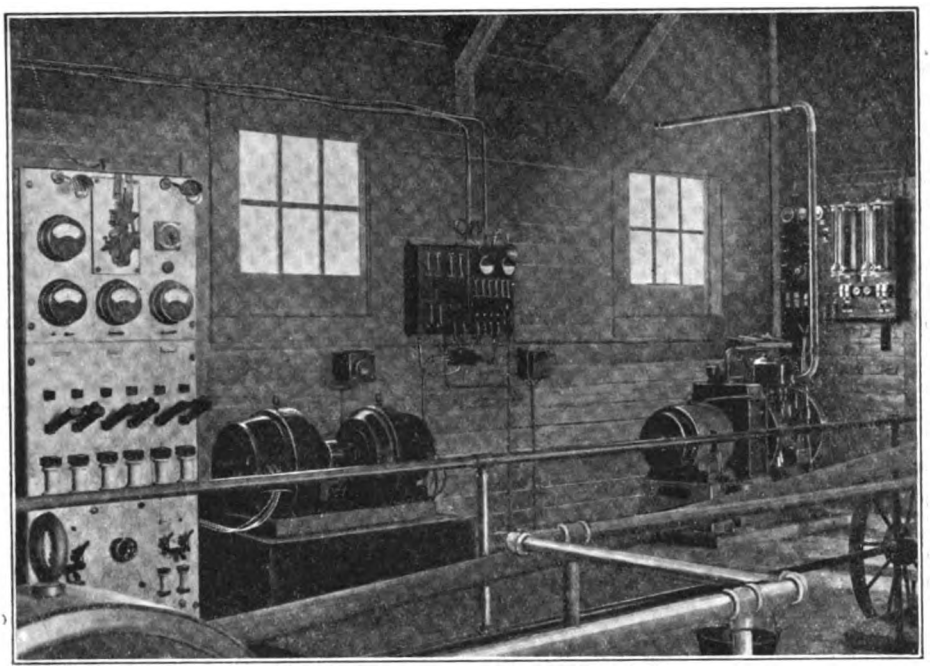

Engine Room, showing Main Switchboard and Motor Generator.

all the aggregate and employing hot water for the mixing.

It was hoped that if conditions permitted the outside work of concreting mast anchorages and foundations might be pushed ahead before the winter set in. Unfortunately owing to local transport difficulties this work was unable to be undertaken before the thaw set in some six months later, and thus it was imperative that if the working of the station was to be expedited the employment of wooden masts should be substituted for the steel ones as a temporary measure. Two 200-feet masts were therefore designed, and during the time these were under construction and erection, the building and installing of the engine and gear were being proceeded with, and by the end of February a four-wire triangular aerial, a conduction earth and the remainder of the installation had been completed, and communication had been established with the British Isles. Work on the steel masts was commenced in the latter part of April and concluded in May, when a more substantial 6-wire triangular aerial was erected.

The receivers comprise two separate sets—one for long, the other for short-wave reception, and consist of simple plain aerial and tuned circuits coupled to Type 55A amplifiers used in conjunction with a Mark 4 three-valve note amplifier.

One of the many difficulties to be encountered during the winter when a temperature of minus 30 degrees was experienced, was the transportation of the engine flywheel, weighing 5 tons, in one piece over a distance of three miles. This was accomplished partly by rail across the river Dvina, when a specially constructed sleigh hauled by two caterpillar tractors was used to haul it to the

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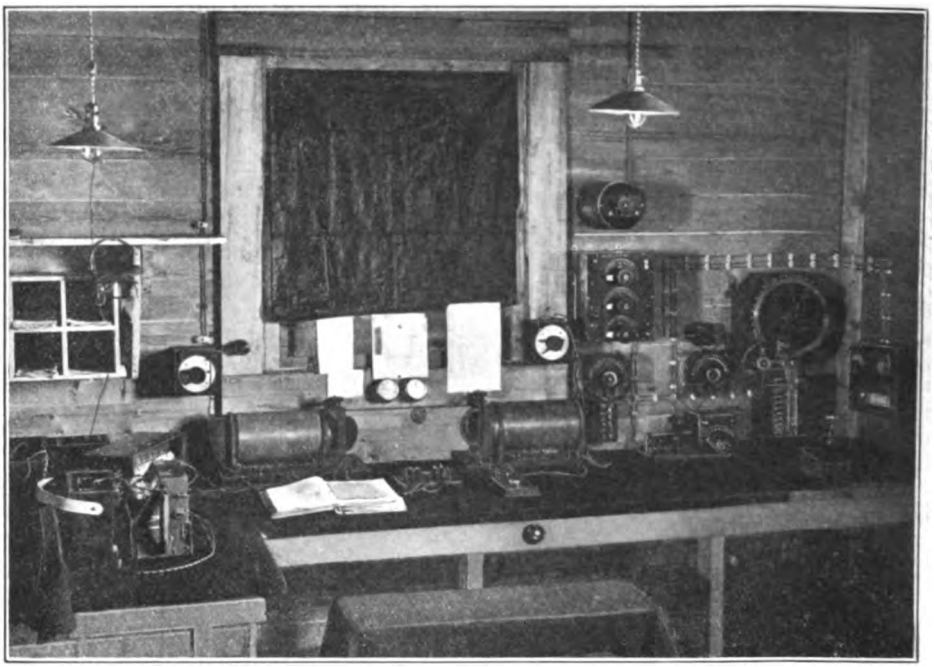

Receiving Room at Archangel Station.

A Scene on the frozen Dvina.

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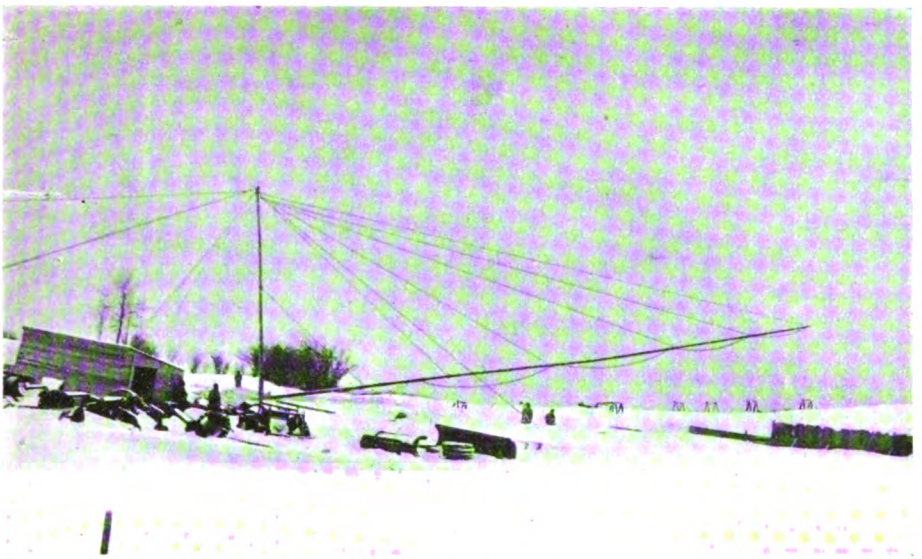

Erection of 200ft. Wood Mast.

site, not without considerable difficulty. Other difficulties encountered were the laying of a suitable symmetrical earth ring in soil which resembled iron in hardness, and the difficulty in keeping all water pipes for engine and arc free from frost, even the smallest crack in the woodwork being sufficient to cause a block with the resultant bursting of the pipe. Even the handling of spanners was sometimes an unpleasant experience, as if left in the open for a short time they were apt to burn one's hands, and sometimes when resort was had to warming them over the stoves one was uncertain if they were genuinely hot or still cold! It was anticipated that silver thaw on the aerial might prove to cause considerable inconvenience and arrangements were therefore made for the aerial to be so designed that a current of over 200 amperes might be passed through it when required.

Atmospherics were also a varying quantity. During the winter they appear to be normal, but when continuous daylight exists in the spring and summer months the conditions reverse themselves, that is to say, the free period is during the night, and atmospherics are severe from 10 a.m. till 4 p.m., when they attain their maximum, falling off gradually till 10 p.m.

Observations were also made of the effect of the Aurora Borealis, and it was recorded that if the display was at all pronounced a continuous roar is heard in the telephones.

Marked improvement results in signalling conditions during the reversal of the seasons. Aerial currents increase practically 50 per cent. when the soil becomes thoroughly conductive and the resistance of the aerial falls proportionately.

On the whole it may be said that the erection of wireless stations in the extreme cold is hardly a humorous pastime—perhaps the Russian engine room attendant thinks differently, however, when he finds another and more agreeable way of disposing of the methylated spirit which the arc chamber always seems to sigh for.

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MR. HERMOD PETERSEN

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Personalities in the Wireless World

MR. HERMOD PETERSEN was born in Christiania in 1875. After entering the Telegraph Service in 1893 he was for some years a telegraph clerk, being at the same time employed in constructing telegraph lines in the North of Norway. Later on he graduated as electrical engineer at Bergen Technical College, and completed his education at the Technical High School of Karlsruhe, Germany. On his return in 1900 he was appointed Chief of the Telegraph Schools, which position he held for 13 years, doing a most valuable work in the developing of systematic theoretical and practical telegraph training. Mr. Petersen contrived to make his pupils feel interested in their work, and most of the younger men in the ordinary as well as in the Wireless Telegraph Service have reason to be thankful to him for their sound training. He remedied the existing want of instructional books by writing quite a number of excellent works on Telegraphy, Telephony and Wireless Telegraphy.

Owing to the large extent and great shipping of the country, Wireless Telegraphy is bound to be of the utmost importance to Norway, and the number of land and ship stations is already considerable and increasing fast. In this development Mr. Hermod Petersen has taken an important part, and is recognised as one of the most prominent pioneers in this domain, commencing as early as 1901, when he superintended the first wireless experiments in the country. He trained the first military and the whole Government Telegraph staff of wireless men, besides delivering numerous lectures with a view to rousing public interest in this new means of communication. As Chief of the Wireless Department, with which position he was entrusted in 1913, he laid down the technical plans and supervised the construction of most of the Wireless land stations in the country. The erection of the Wireless Station at Spitsbergen, which was attended by considerable difficulties, Mr. Petersen undertook as Engineer-in-Charge, and in order to ensure its good working he remained in charge during its first winter of Arctic night. As representative of the telegraph department he has had the control of the erection of the large station near Stavanger, which is to communicate with America, and as Government Wireless Inspector he controls all the ship stations of the country. Since July, 1919, he has held the post of Chief Wireless Engineer of the Norwegian Government Wireless Stations.

Mr. Hermod Petersen's recognised ability in the field of theoretical research, combined with sound, practical knowledge and a vivid interest in wireless work in general, renders him eminently suitable for the important position he holds. In connection with his work he has travelled in England, France and Germany, and he was a member of the first International Conference on Wireless Telegraphy held in Berlin in 1906.

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Simplified Inductance Calculations

WITH SPECIAL REFERENCE TO THICK COILS.

By PHILIP R. COURSEY, B.Sc., A.M.I.E.E.

Abstract of Paper read before the Physical Society of London *(Proceedings of the Physical Society*, 31, pp. 155-167, *Aug., 1919.)*

1. The predetermination of the inductance of coils by direct arithmetical calculation is a subject to which a great deal of attention has been devoted. The results are seen in the many published Papers giving formulæ for this purpose. Most of these formulæ have been obtained by rigid mathematical deduction, but some are empirical. Many are very complicated, and unsuited for easy computation.

Several writers have attempted the simplification of some of these formulæ to render them more suitable for everyday use. Often this has resulted in a limitation of their range of applicability to certain selected cases, and in some instances confusion has arisen through imperfect statement of the limits between which the particular formula may be employed.

2. *Notation.*

Let—

L = Inductance of coil in centimetres.
D = Mean diameter of coil (cm.) = $2a$.
a = Mean radius of coil.
l = Axial length (cm.).
d = Radial depth of windings (cm.).
N = Total number of actual turns of wire.
$n = N/l$ = Number of turns of wire per centimetre of length.
k = Correction factor for single layer windings.
δk = Correction for coil thickness.
k' = Correction factor for thick coils.
m, A, B, &c. = Other factors used in various formulæ.

3. *Single Layer Coils.*

The calculation of the inductance of single-layer coils has, perhaps, received most attention in the direction of simplification on account of the practical requirements in the realm of wireless and other high-frequency apparatus. Several abacs, charts and curves have been published with this end in view.

When dealing with single layer coils one of the most useful, and, at the same time, most accurate and universal of the available formulæ is that of Nagaoka.* The main part of this formula, viz.:—

$$L = \pi^2 D^2 n^2 l k \quad . \quad . \quad . \quad . \quad . \quad (1)$$

* Nagaoka, "*Journal*" *College of Science, Tokyo*, XXVII., p. 18 (1909); also "*Bulletin*" *of Bureau of Standards, Washington*, VIII., p. 119 (1912).

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is very easily dealt with, but the expressions for calculating the factor k for the various cases of long or short coils are very cumbersome and tedious to use. Extensive tables of this factor have, however, been published in the "Bulletin" of the Bureau of Standards, and elsewhere, giving the values of k in terms of the ratio D/l = diameter ÷ length of the coil.

The use of this formula in practice may be simplified by plotting curves of the values of k and reading the value required from these. This method has other special advantages when the design of a coil to have any predetermined value of inductance is under consideration, as has been previously pointed out by the author.*

The results given by this formula are, strictly speaking, liable to a correction for the insulation or spacing of the turns of wire, but in practice this correction is a small one (usually less than 1 per cent.), and may be neglected—at least to the approximation required for most practical work, for which curves are applicable.

This formula may be expressed in a number of different ways if so desired. Such modifications have given rise to a number of abacs and charts to simplify its use. In general, however, they amount to the same result as that given by the curves above, while their range is usually much more limited.

As an example we may mention Eccles's abac given in his "Handbook of Wireless Telegraphy." This is based on Russell's formula, and is written in the form

$$L = ma^3n^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Values of m are obtained from the abac in terms of the ratio l/D

If we equate this expression to the one used by Nagaoka, we have

$$m\,(D/2)^3n^2 = \pi^2D^2n^2lk,$$

or,

$$m = 8\pi^2\frac{lk}{D} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

We may therefore compare the results obtained by the two methods by working out values of $8\pi^2[lk/D]$.

Curves of lk/D were given by the author in the *Electrician*† for the purposes of the design of coils. Using these curves, we obtain the following table:—

l/D	lk/D from curve.	$8\pi^2lk/D$.	m from abac.	Difference per cent
0·2	0·063	4·96	5·00	+0·8
0·65	0·384	30·3	30·2	—0·33
1·5	1·15	90·8	91·0	+0·22
2·4	2·04	161·0	160·0	—0·62
4·2	3·80	300·0	300·0	0·0
5·2	4·78	384·0	379·0	—1·3

The agreement is evidently very close. The useful range of the abac is, however, much more limited than that of the curves. It is only useful for comparatively short coils.

A very similar chart due to S. Lowey, published in the WIRELESS WORLD.‡

* P. R. Coursey, *Electrician*, LXXV., p. 841 (September, 1915).
† P. R. Coursey, *Electrician*, *loc. cit.*
‡ S. Lowey, WIRELESS WORLD, III., p. 664 (January, 1916).

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amounts to practically the same abac arranged in a circular form, but with a slightly greater range, and expressed in terms of the coil diameter instead of its radius.

A disadvantage of transforming Nagaoka's formula in this manner, viz.: splitting it up into factors of D^3, and lk/D, is that the factor m, which is proportional to lk/D, covers a much greater range of values—varying between 0 and ∞ —whereas the factor k is asymptotic to unity, and its value for all cases lies between 0 and 1. A curve or abac for k does not, therefore, require to be so extended.

4. *Thick Coils.*

When we come to consider the case of coils having a radial thickness that is not negligible compared with either the diameter or the length, these simplified formulæ become very inaccurate if used as they stand. Moreover the usual accurate expressions for these cases are not easy to work with in the forms generally given. These coils—" thick coils," as we may term them for distinctive purposes—have not perhaps quite such a wide sphere of use as the single layer coils, but, nevertheless, they are of importance in some branches of engineering, and are finding more extended use for high-frequency work than hitherto.

It is understood, of course, that these calculations always refer to " air-core " coils, or to be more general, to all coils having a core of permeability unity, as the inductance of iron-cored coils is too uncertain and variable a quantity to require predetermination in most cases.

The principle object of this Paper is to indicate how the simplified form of Nagaoka's formula, using the " k " curves, may be adapted to a general method of calculation applicable to all types of coils, whether thin or thick, short or long, of one turn or many.

In the single layer case considered above, the magnetic flux passing through the centre of the coil is linked with practically all the turns—the factor k correcting for the spreading of the flux at the ends of the coil. Evidently when more layers are added to the coil, the flux due to the inner layers does not link directly with the outer layers of wire, so that the effective inductance is less than it would be if the same number of turns were all concentrated upon a single outer layer. It should, therefore, be possible to allow for this reduction in inductance by introducing an appropriate reduction in the factor k. For this purpose a series of values of a factor δk have been calculated. This factor is to be subtracted from the proper value of k obtained from the curves, and the new value k' used with the standard formula (1) in the usual manner.

Hence we have

$$L = \pi^2 D^2 n^2 l\ (k - \delta k)$$
$$= \pi^2 D^2 n^2 l k'. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where $k' = (k - \delta k)$.

A series of values of this reduction factor δk have been worked out by using Rosa's formula* for the inductance of a thick coil. This easily gives us an expression in the form required, from which we get

$$\delta k = \frac{2}{\pi} \cdot \frac{d}{D} \cdot (A_1 + B_1) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

* E. B Rosa, "*Bulletin*" *of Bureau of Standards*, IV., p. 369 (1907); also VIII., p. 138 (1912).

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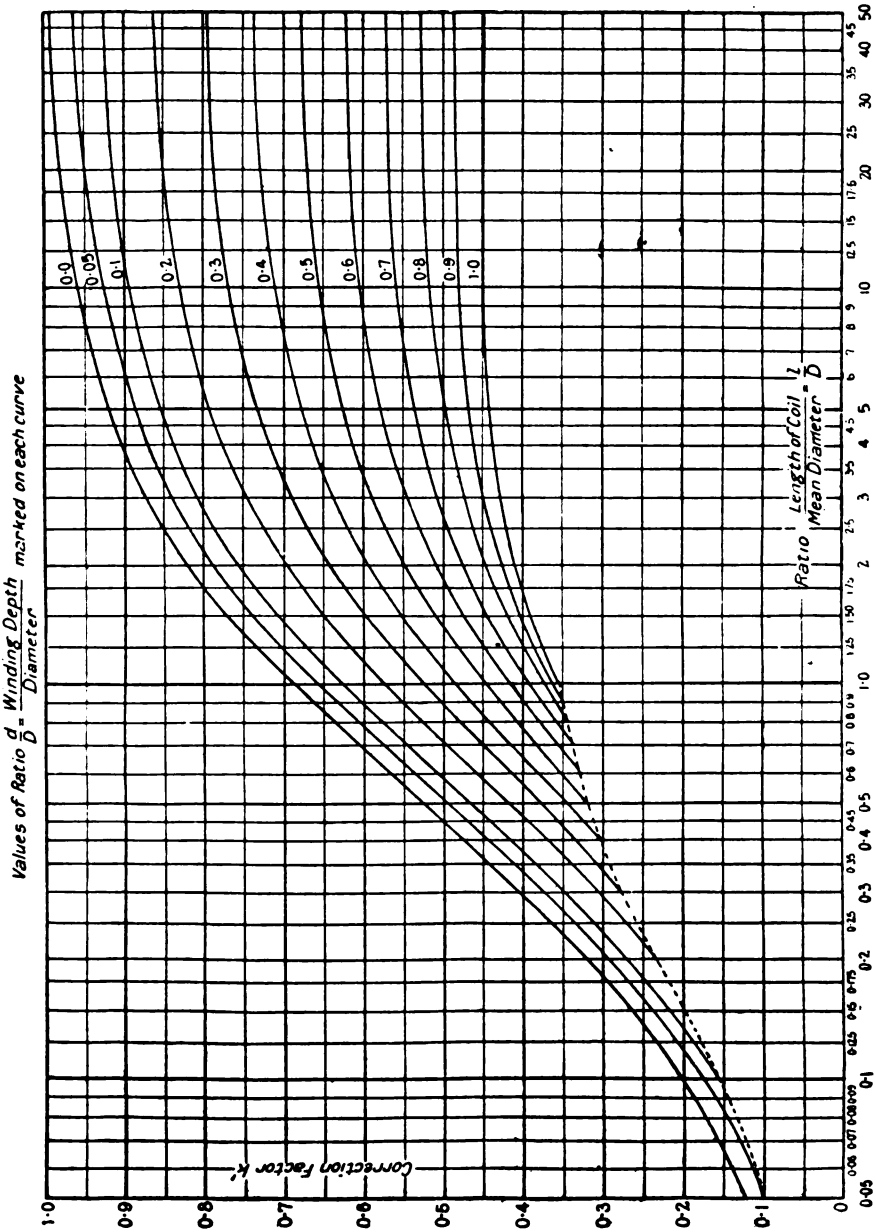

Fig. 1—Curves of Factor k' for all Coils (thick or thin).

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The values of δk have been calculated from this expression by using the values for A_1 and B_1 tabulated by Rosa. A considerable number of extra values have also been calculated from the formulæ given in his original Paper*, as the tables were found insufficient for this purpose.

Evidently not only is it possible to plot curves of δk, as has been indicated, but a set of curves of the factor $k' = k - \delta k$ may also be plotted on one sheet to enable the appropriate factor for *any* coil to be read off at a glance. See Fig. 1.

These curves are plotted against the ratio l/D (=length ÷ diameter), so that the k curve for a single layer coil can also be included. A wide range of values is obtained by the use of the logarithmic scale. In using the curves it should be noted that when the winding depth d is greater than the axial length l, the values of l and d should be interchanged in working out the inductance both in the formula and in finding the factor k'. The inductances of the short thick coil and the long thin one of Fig. 2 are practically the same, provided that the mean diameters are identical.

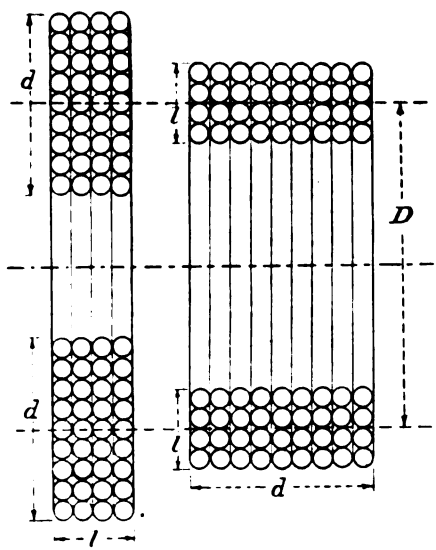

Fig. 2 Equal inductance Coils.

The results obtained from these curves have been compared with measurements on several coils, and have been found to be generally correct within a few per cent.

These k' curves have an advantage in being asymptotic as compared with others, in which the formula has been broken up into factors of n^2, D^3, and m, as for the single layer case (Eccles's Abac, &c.), equation (2), or into factors of N^2, D, and $(A - B)$, as in L. A. Doggett's chart.†

The method of calculation adopted for the factor δk does not, in its present form, admit of its calculation for values of $l/D < d/D$, and it will be noted that

* E. B. Rosa, *loc. cit.*

† L. A. Doggett, *Electrical World*, January 31, 1914; *Electrical Review* (Lond.), LXXIV. p. 489 (1914).

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in consequence the k' curves as given do not extend beyond this value. This point corresponds to the square section coil, length = depth. Shorter coils may be calculated to a first approximation by interchanging l and d as indicated above. It is hoped in a later communication to deal with the extension of these curves to the smaller values of l by an alternative method of calculation.

6. *Single-turn Rings.*

Another use for these curves should also be noted—viz., their application to coils of very small section, down to the case of single turns of wire.

Taking the latter as an extreme case, it may be regarded approximately as a " square-section " coil of length = depth = diameter of wire. As an example: —

A single turn of wire of mean diameter $D = 10$ cm. and wire diameter = 0·5 cm: —

$$l = d = 0{\cdot}5 \qquad l/D = 0{\cdot}05 = d/D.$$

$$\therefore k' = 0{\cdot}1015$$

$$\therefore L = \pi^2 \times \frac{10^2 \times 1^2}{0{\cdot}5} \times 0{\cdot}1015.$$

$$= 200 \text{ cm.}$$

The actual inductance of this ring = 192·2 cm.

To render this method of calculation more easily applicable to these cases, a series of values of k' for very small values of l/D and d/D have been calculated. They are set out in Fig 3.

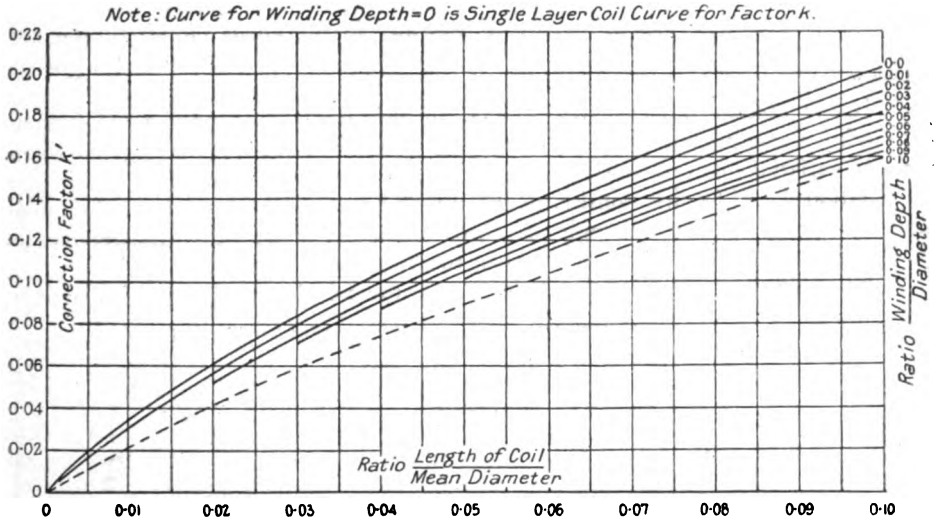

Fig. 3—Curves of k' for Coils of very small section (= Lower part of Fig. 1 to enlarged scale.)

These low-range curves of k' do not extend to values of l/D less than d/D, for the reasons already given.

In conclusion, it is hoped that this indication of a uniform and easy mode of calculation of the inductance of all ordinary shapes of coils may be of some utility in practical work, by limiting the number of formulæ to be memorised or to become familiar with, and thus leading to less confusion and error.

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Digest of Wireless Literature

ON A NEW VALVE CIRCUIT FOR THE RECEPTION OF ELECTRIC WAVES.

By G. LEITHAUSER.

Jahrbuch der drahtlosen Telegraphie und Telephonie, July, 1919.

THE Audion of De Forest consists as is well known of a high vacuum bulb in which an electrically-heated filament emits a copious supply of electrons. The flow of these electrons to the positive anode can be controlled by varying the potential of the grid with respect to the filament. The early workers with tubes in which remained an appreciable amount of gas termed these instruments "Ionic relays," but latterly, when valves of the highest attainable vacuum are used, the term "Electron relay" is more appropriate. Although the early work with valves was directed towards the development of high-frequency amplification, experimenters during the war tended to work mainly at the problem of amplifying the audio-frequency signals obtained from a detecting circuit. The results obtained by this method really justified the amount of attention given to this problem. The normal method used was to include the primary of an iron core transformer in the anode circuit of the first valve and allow the induced voltage in the second coil to actuate the grid of another and so on.

Just at present, however, the problem of high-frequency amplification is again occupying a conspicuous place. Two types of methods of transferring the anode voltage variations of one tube to the grid of the next in a cascade of valves may be mentioned. The first consists in the use of air core transformers in the anode and grid circuits. An assembly of three valves in which the transference of energy from valve to valve is obtained in this manner is shown in Fig. 1.

The transformers must be so designed that the coils have only a small diameter,

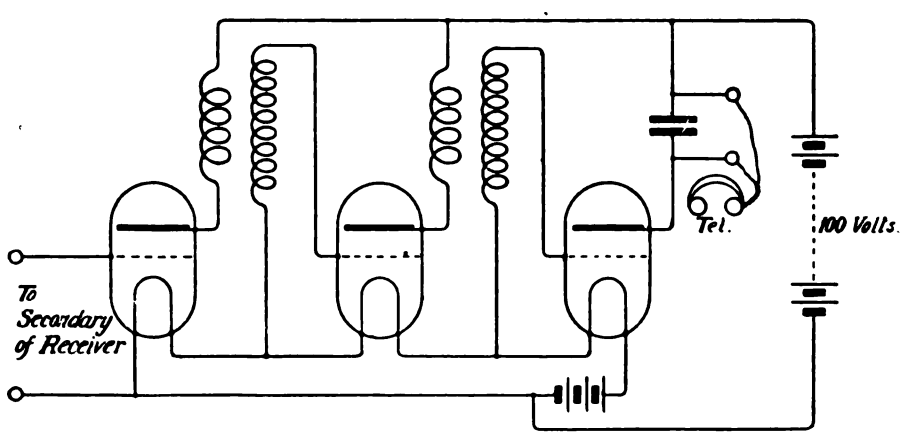

Fig 1.

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as otherwise these act as direct receivers themselves giving rise to much troublesome interruption when signals from a very distant station are being received. In view of the fact that the spaces between the valve electrodes have high resistances the impedances of the transformer coils can also be made high. The magnitude of the impressed grid potential evidently depends on the magnitude of the anode voltage variations of the preceding valve; while the latter is dependent on the anode voltage, the anode circuit resistance, and particularly on the resistance of the transformer winding between the anode and the anode battery. In utilizing high resistances one would expect large variations of anode potential.

A second method of transferring the potential variations to the second valve (which first appears to have been used in America) consists in the use of a condenser C of small capacity (see Fig. 2.)

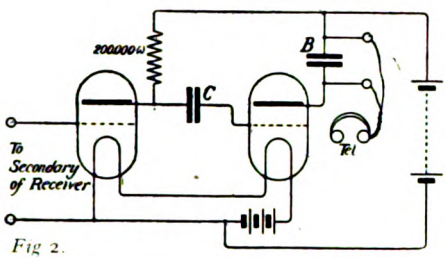

Fig 2.

This condenser is connected on one side to the anode of the first valve and on the other side to the grid of the second. The second valve in Fig. 2 has included in the anode circuit a blocking condenser B to the plates of which the receiving instrument is connected in the usual way. As the transference of potential is brought about now by the condenser C we can replace the primary of the transformers of Fig. 1 by an ordinary ohmic resistance. This usually is of the order of several hundred thousand ohms.

In the case of several tubes connected together as an amplifier with condensers to transmit the voltage variations from valve to valve and with an *inductive* high resistance inserted between anode and battery, we have an arrangement which is singularly sensitive and which can be brought to the point of instability by altering the filament current. In such a condition the amplifying power is enormous.

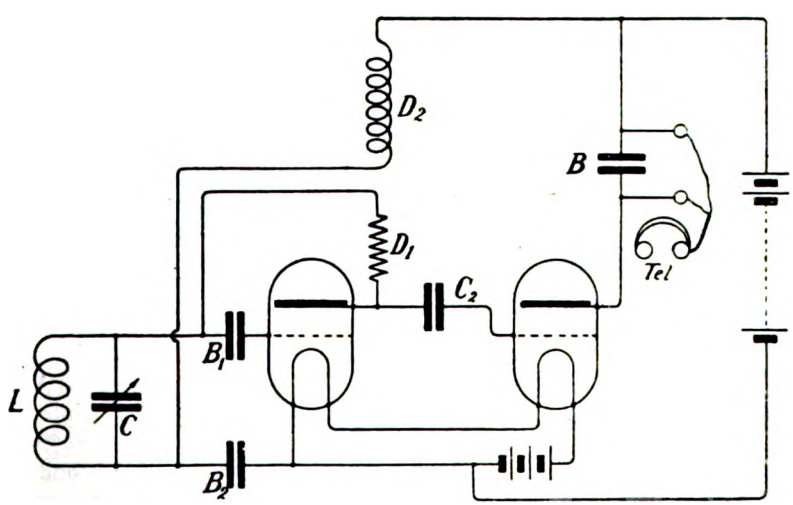

Fig. 3.

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In fact it is over-sensitive, for if such an amplifier is brought near to the secondary circuits of a long wave receiver the coils of which have a diameter of say 20 cm, the energy transferred from these coils to the amplifier in the case of a neighbouring sending station is sufficient to produce signals, although the oscillatory circuit it not tuned to them. Also when situated quite free and not joined to a coil such an arrangement will reproduce the more powerful stations.

To remove this difficulty of interference the following arrangement has been evolved. It differs from the two circuits previously described in that the oscillatory circuit LC is connected to the anode of the first valve. This arrangement is shown in Fig. 3.

The oscillatory circuit is symmetrically placed with respect to the two high resistances D_1 and D_2 which are wound on bobbins of small diameter. The variations of potential across C are transferred to the grid and filament by means of the blocking condensers B_1 and B_2. The condenser C_2 serves to transfer the variation of anode potential to the grid of the second valve.

This arrangement has been carefully tested and found to be extremely sensitive to waves of the same frequency as the LC circuit, but extremely insensitive to other frequencies.

THE PRODUCTION AND MEASUREMENT OF SHORT CONTINUOUS ELECTROMAGNETIC WAVES.

By DR. B. VAN DER POL.

Philosophical Magazine, July, 1919.

CONTINUOUS electrical oscillations of a wavelength of 6 metres have been obtained by W. C. White using a thermionic valve generator. By using a small hard receiving valve and similar circuit it has been found possible to obtain a wave length a slow as 3.65 metres. The circuit used is shown in Fig. 4, where P, G, and F represent the plate, grid, and filament respectively of the valve. The tuned plate circuit can be considered to consist of the wire P B C principally acting as inductance in series with the condenser C, and the capacity existing between the filament and plate. The grid circuit which is also tuned is formed by the wire G A F (which again principally represents the inductance) in series with the condenser formed by the filament and grid.

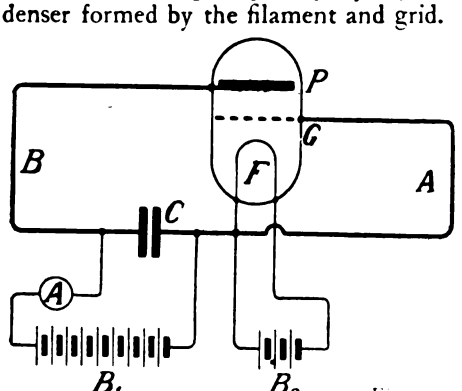

Fig. 4.

The necessary reaction from the plate circuit on the grid circuit is here obtained (instead of by the usual electromagnetic coupling) by a capacity coupling inside the thermionic tube, the grid being placed in the electric field between filament and plate. It happens that this coupling has the proper sign to maintain strong oscillations.

The wires P B C and G A F were each about 60 cms. long, while the connection C F was kept a few centimetres. The variable condenser C consisted of two circular metal plates of 5 cms. radius, the distance between which could be varied.

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How Aeroplanes are Navigated by Wireless

By R. Keen, B.Eng.

THE Wireless Direction-Finder depends for its action on a property possessed by a frame aerial when used for reception, namely, that the current induced in the aerial is a maximum when the plane of the aerial coincides with the direction of the incoming waves and is a minimum when the frame is turned through a right angle. It will be seen, therefore, that if a frame aerial is made in the form of a rectangle and after being erected in a vertical plane is arranged so that it can turn about one of its vertical sides as an axis, the approximate direction of received signals can be found by swinging the aerial round until the noise in the telephone receivers is a maximum. This arrangement, however, is of little use in practice and a brief description will now be given of the Wireless Direction-Finder or Radiogoniometer as developed by the Marconi Company and which has proved of such enormous value during the war for the location of enemy wireless stations whether on land or sea or in the air.

Two frame aerials are used in this case and are either triangular or rectangular in shape. They are supported in a vertical plane and are arranged so as to be exactly at right angles to each other and symmetrical about a common vertical axis. The direction-finding instrument itself (D.F.) consists of two sets of field coils also arranged at right angles and a search coil which is mounted at the centre of these field coils and is capable of turning about a vertical axis which is also common to the two field coils. The arrangement is seen fairly clearly in Fig. 1. The two aerials are connected in series with the two coils respectively, and the search coil is connected to the receiving apparatus which may be of any standard type although a valve amplifier is almost universally used. In certain types of D.F. the field coils are each wound in two halves and condensers are inserted at the mid points for tuning the aerial system to the wavelength to be received.

Now consider what is the effect of a wireless signal which is received on this

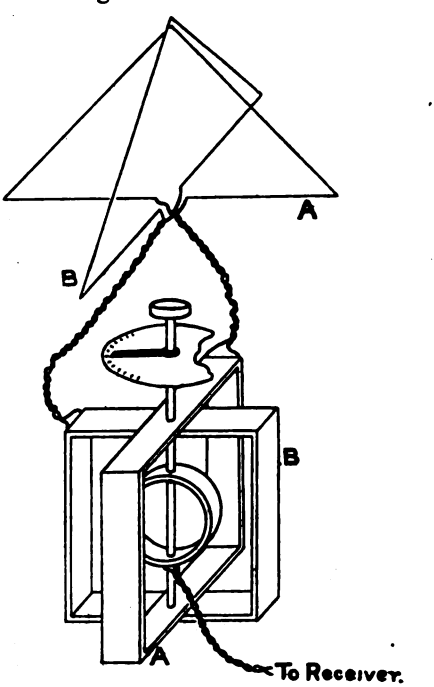

Fig. 1.

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system. Suppose first of all that the signal is arriving exactly in the plane of the A frame (Fig. 1). In this case a current will be induced in the A aerial and hence in the A field coil and will produce a magnetic field along the cylindrical axis of the coil. On the other hand, in the case of a signal which is received exactly in the plane of the B aerial, a magnetic field will be produced along the axis of the B coil. If, however, the direction of the received signal is somewhere between the planes of the aerials, both aerials and hence both field coils will have currents induced in them and in the neighbourhood of the search coil there will now be two magnetic fields at right angles to each other, the relative strengths of which will depend upon which aerial is being affected to the greater extent. It can easily be shown that these two magnetic fields produce a resultant field which bears precisely the same space relationship to the axes of the field coils as the direction of the received signal does to the planes of the frame aerials. The problem remaining then is simply to ascertain the exact direction of this resultant field, and this is done by means of the rotating search coil. As the search coil is moved round, the signals in the telephone receivers are heard to rise to a maximum strength, which is when the maximum magnetic field is threading the coil, and to fall to zero on rotating the coil through a further right angle, in which case no magnetic flux is cutting the search coil. A pointer is attached to the spindle of this coil and a scale is fixed to the framework of the instrument so that the direction of the received signals, relative to the direction of the aerials, can be read off.

In the case of a land station the directions of the aerials are known and hence the bearing of any transmitting station can at once be found. On the other hand, in the case of an aircraft installation, the positions of the transmitting stations on land are usually known and the direction-finder can then be used to measure the angles which these known stations subtend at the aeroplane from which readings the position of the aeroplane can readily be found.

It is impossible in the space of this short article to enter into details concerning the instrument or the precautions which must be taken in its manufacture and installation in order to obtain the great accuracy of which it is now capable, and we must now pass on to a description of how the exact position of a transmitting station is found by means of two shore D.F. stations and then to the methods employed whereby an aeroplane can be navigated entirely by means of bearings taken on distant wireless stations from the plane.

In Fig. 2, suppose X and Y to be two D.F. stations which have been carefully calibrated with respect to true North so that the direction which any incoming signal makes with the meridian can be found. It is required to find the position of some station Z. Both stations at X and Y stand by until they hear Z transmitting and then they simultaneously take his directions which are shewn as 110 and 45 degrees, respectively, East of North. These readings are then communicated to a person having a chart with the positions of X and Y marked and on plotting the two directions as shown by the D.F., the position of Z is at once seen to be at the inter-section of the lines. A serious difficulty arises here in the choice of a suitable chart to use for the purpose. The reader who is interested in the many different ways in which the curved surface of the earth may be projected in the shape of a map, in order to meet various requirements, is strongly advised to study the article on Wireless Maps

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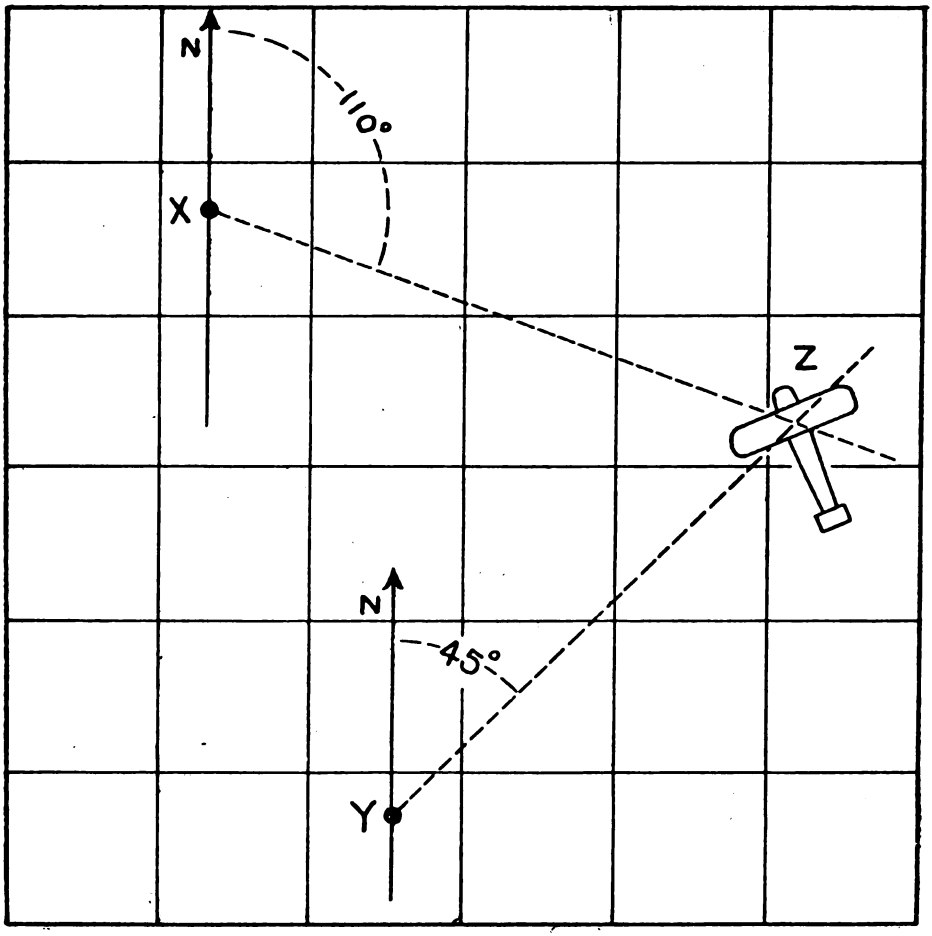

Fig. 2.

which appeared in the May issue of the WIRELESS WORLD. Some of the difficulties which are met with in long-range wireless direction finding will then be appreciated though they can only be very briefly dealt with here.

Owing to the curved shape of the surface of the earth, it is impossible to reproduce it on a plane without a certain amount of distortion. The wireless waves travelling from Z to Y in Fig. 2 do so along what is called the "great circle" through these points, and this is the shortest distance along the curved surface of the earth, joining Z and Y. Since we are going to plot this direction on a chart by means of a protractor and a straight edge, it must appear as a straight line. Similarly, since we are measuring the angle which this line makes with the meridian through Y, it follows that the lines of longitude must also appear as straight lines. These conditions are complied with in a chart called a "Gnomonic Projection," but the parallels of latitude are found to be curves. If the more familiar " Mercator's Projection " be used, the lines of latitude and longi-

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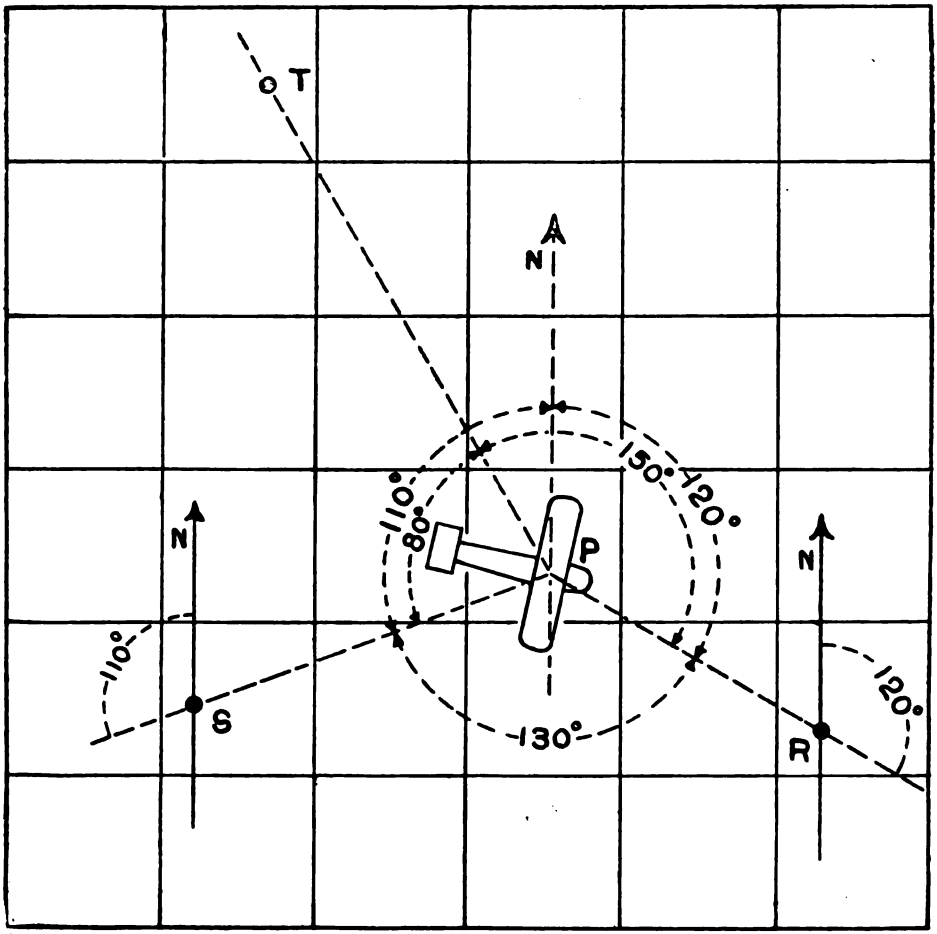

Fig. 3.

tude are straight but the great circles appear as curves and so on. For the purpose of this article it may be assumed that the distances apart of the stations are small so that an ordinary map may be used without appreciable errors; latitude, longitude and the direction of travel of the waves all being taken as straight lines.

Referring to Fig. 3, suppose P to be an aeroplane in flight which wishes to find its position with respect to certain shore transmitting stations which are within range. By means of the D.F. the navigator takes the bearings of one of the stations, say R, and at the same time notes the magnetic compass bearing of the plane. From these two readings, after necessary corrections, the direction PR is found to make an angle, say, 120 degrees East of North. In a similar manner the direction PS may be found to be 110 degrees West of North. If these directions are now laid off on a chart *from* the points R and S, the position of the aeroplane must have been approximately at the point of intersection of the lines SP, RP when the read-

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ings were taken. Allowance must be made for the distance travelled by the aeroplane during the process. If, for any reason, the magnetic compass is out of commission or is not trusted, the position of the aeroplane may be determined entirely by means of the D.F. by taking the angles subtended at the plane by any three transmitting stations whose positions are known. In Fig. 3 suppose T to be the third station. Readings are taken of R, S and T in rapid succession, and supposing the angles TPR, RPS and SPT are found to be 150, 130 and 80 degrees respectively, then by means of geometry or better still by the use of a "Station Pointer" the point P can be rapidly located on the chart. The instrument just referred to consists of a special form of protractor with three arms which can be adjusted to any angle. These arms are rotated until their directions represent the directions of R, S and T from P, and on placing the instrument on the chart so that the arms cut through the respective points, the centre point of the instrument shows the position of the aeroplane.

From these readings, not only the latitude and longitude of the aeroplane but also its direction of flight is found so that navigation can be carried out accurately in almost any weather conditions. In the case of the transatlantic flight, the problem of navigating entirely by D.F. is particularly simple. Directly after leaving Newfoundland, an aeroplane is able to follow the great circle through the High Power transmitting stations at Glace Bay, Nova Scotia, and Clifden in Ireland. Signals from these two stations will therefore always be exactly 180 degrees apart on the D.F. Any " drift " on the part of the aeroplane will be at once detected by a change in the angle between the stations, and it is only necessary to alter course until the directions are again correct. By this means the shortest course is maintained with consequent saving in time and fuel.

With the development of commercial flying and the necessity of making long journeys to scheduled times and regardless of weather some method of navigation which does not necessitate a clear sky is essential and a great future for wireless navigation is already assured.

(In a future number we shall publish another article on the Wireless Direction Finder, dealing with the practical difficulties to be overcome in installing the system on aircraft, and giving our readers some ideas of the latest evolved form of the apparatus.)

WIRELESS AND LONGITUDE.

Under the auspices of the French Bureau des Longitudes, wireless telegraphy is shortly to be applied to a longitude determination of a complete circle of the globe. Three almost equidistant places have been chosen—Paris, Shanghai, and San Francisco—each separated from any one of the other two by approximately one-third of the earth's circumference. Accurate clocks at these places will be compared by means of wireless signals from three other places—Annapolis, Honolulu, and a French Station are suggested—and as 15° of longitude are equal to an hour's time difference, instantaneous comparison of the clocks at the three places selected for the experiment will enable the differences of longitude to be accurately calculated.

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"W/T. R.E."

An Account of the Work and Development of Field Wireless Sets with the Armies in France.

By Capt. B. F. J. Schonland, O.B.E., R.E., late Staff Officer (Wireless) 1st Army, France.

(Continued from August Number.)

SPACE forbids my telling much of the minor communications which were provided by the ever-present C.W. set. Once we were moving forward rapidly it was impossible to provide the long telephone lines required by the anti-aircraft system, to link up "spotting" parties with guns, and guns with other guns. A big system of C.W. communication was therefore provided for "Archie", and gave splendid service. The Royal Air Force, too, had a complete system of C.W. ground communications between Brigades, Wings and Squadrons. These did good work, but a description of their activities is not within the scope of these articles.

The retreat of the enemy in the opening days of November was marked by nothing if not by its celerity, and the corresponding speed of our advance lead to a real clamour for wireless sets of all descriptions.

Requests were even received for wireless facilities for the use of R.T.O.'s. at railway stations! During the last few weeks of the war the aether in the zone of the British Armies was in a terrible state of agitation. Wireless sets with infantry, artillery, cavalry, tanks, armoured cars, scouts, anti-aircraft guns, all were working at red-hot speed.

And then, not unexpectedly, but suddenly all the same, so dramatic was its significance, came the message from the Eiffel Tower which rang down the curtain on the world-war. At 5 a.m. on the morning of November 11th, when the operator on spark or C.W. set was drowsily wondering how soon the day's attack would mean another day's "S.O.'s." and "D.'s." came the message—"Marshal Foch to the Allied Commanders.—Hostilities will cease at 11 a.m.————." That message was *delivered* in well over half the cases, delivered to the fighting troops by wireless. And in the tumultuous crash which followed, in the repetition of the message by the thousands of wireless sets in the army, one recalled another wireless message. Date—August 4th, 1914, a big German land station to ships at sea:—"War has been declared with Russia, France, and England, England, England, *England.*"

With the delivery of the orders for the armistice the real work of the W/T Section, R.E., was done. I cannot, however, refrain from recalling how, soon after eleven o'clock that memorable morning, direct communication was established by wireless between our G.H.Q. and our headquarters of armies, and those of the Germans. Messages were soon exchanged concerning the safe passage of German officers to arrange certain details of the armistice conditions, to hand over material, reveal unexploded land mines, etc. This direct communication between the two sides continued for some time. When our troops set off on their long march to the Rhine, great use was made of wireless sets of all kinds to provide communication between scattered units on

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the move. Their success in that capacity is the last chapter in the history of the "W/T.R.E."

The foregoing pages have attempted to present an account of the development of trench wireless, from the early sets on the Somme to the huge organisation, forming part of the Signal Service, and numbering some three thousand men and a hundred officers at the time of the armistice. I have tried to give the reader some idea of the results obtained, which exceeded the expectations of the most sanguine wireless enthusiasts. In an historical account it is difficult to find place for a detailed description of technicalities. This as well as an account of the difficulties and heroism of the operators, to whom all credit for success is due, I hope to treat of later, with some account of the work of Wireless Observation Groups, and listening sets.

A Trench Station.

The development of wireless with the army was far from reaching finality by November 11th On the contrary, if the war had been further prolonged, a few months would have seen vast changes. The number of sets would have been doubled, perhaps trebled. "Hullo Sparks! Got any messages through?" Sparks can afford to smile.

Having completed a brief historical account of field wireless sets with the armies in France, I propose now to give the reader an idea of the various technical difficulties encountered and overcome.

It will have been seen from the maps given in previous articles, that the wireless communications were arranged on the " group " system. The arrangement for working and controlling the spark sets in an army corps are shown in Fig. 1. Each corps used one wavelength of the three—350, 450 and 550 metres –available. Although this looks cumbersome on paper, in practice it was usually found that divisions such as those marked 49th and 32nd could carry out communication with brigade stations without interference. Any trouble, however, arising from jamming was attended to by the " directing " station concerned, divisional, corps, or army. The word of the " D.S.'s." were also on the watch for carelessness in ciphering messages and mistakes in procedure, as well as to assist with their more powerful sets, in case a brigade station could not be roused by its division.

Difficulties of manufacture delayed the production of an improved spark trench set, which would have made it possible to give each divisional group a separate wavelength and thus improve communication. Fig. 2 shows the al-

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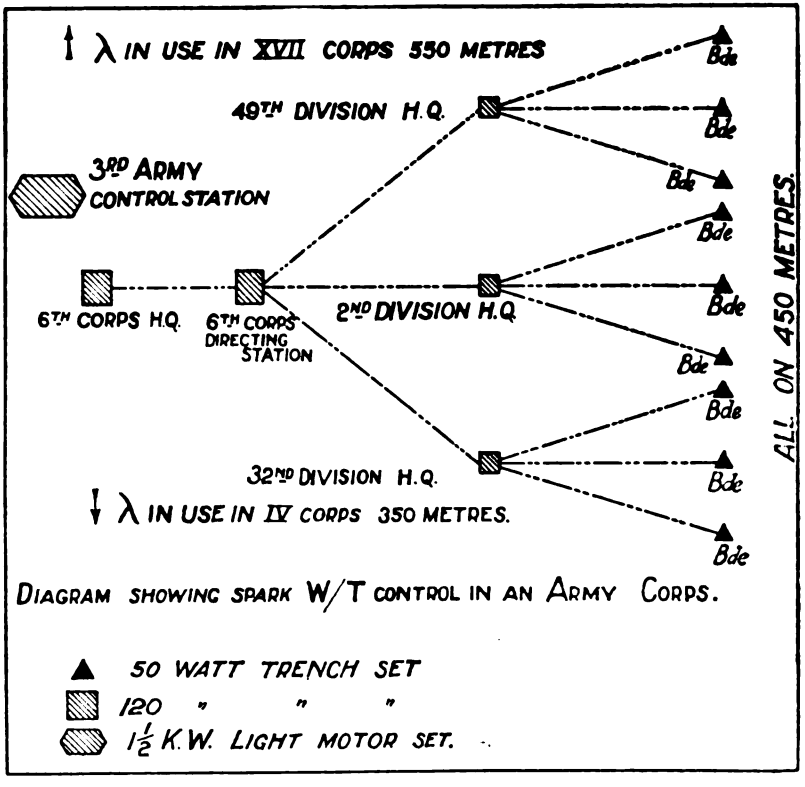
λ IN USE IN XVII CORPS 550 METRES
49TH DIVISION H.Q.
3RD ARMY CONTROL STATION
6TH CORPS H.Q.
6TH CORPS DIRECTING STATION
2ND DIVISION H.Q.
32ND DIVISION H.Q.
λ IN USE IN IV CORPS 350 METRES.
Bde
ALL ON 450 METRES.
DIAGRAM SHOWING SPARK W/T CONTROL IN AN ARMY CORPS.
50 WATT TRENCH SET
120 " " "
1½ K.W. LIGHT MOTOR SET.

Fig. 1.

lotment of wavelengths amongst the various arms of the service.

The group system was also applied to C.W. sets with the artillery, though owing to the larger number of possible wavelengths (about thirty) the number of stations in a group rarely exceeded five. A complete scheme, involving " circuits " with only two stations using a particular wavelength, would have been introduced as more sets became available. Fig 3 shows a typical army corps C.W. system.

The C.W. wavelengths used by forward sets varied from six hundred to two thousand metres, though in general only 700-1,400 metres were employed in cases where short aerials had to be put up. Jamming from " 550 " spark sets troubled 600-700 metres C.W. if used in the vicinity. It was, however, found possible to utilise wavelengths only twenty-five metres apart, for stations working in the same area. To ensure that the correct wavelengths were kept, a system of daily transmission of standard wavelengths from G.H.Q. or Army H.Q. was introduced, and standardised valve wavemetres were kept on every station.

During the last few months of the war so many C.W. sets were used that almost every available wavelength was in use. To control these stations adequately, and to watch their communication, would have required about thirty control stations. Though the Canadian corps, whose wireless was a model of efficiency and successful organisation, made a C.W. receiver capable of simul-

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ALLOTMENT OF WAVELENGTHS AMONGST VARIOUS ARMS OF THE SERVICE

λ. METRES	SPARK USED BY	λ. METRES	CONTINUOUS WAVE USED BY
65 and 80	Loop sets	600—2000	Artillery
100—300	R.A.F.		Anti-Aircraft
350, 450, 550	B.F. Trench sets		Scouts and observing parties
600—1000	Tanks and Cavalry		Tanks
1100	G.H.Q. & Army H.Q.		R.A.F. ground stations

Fig. 2.

taneous reception on seven wavelengths, the general method employed was for the control station to search round each wavelength and listen in for so many minutes.

Jamming between the two systems, spark and C.W., in use in the same area was not excessive, provided two such stations were not very close together and that excessive C.W. ranges were not attempted. At the same time every C.W. operator breathed a sigh of relief when KBU (Bruges) ceased his activities on a thousand metres as a result of our Flanders advance last year.

Personnel and equipment of wireless stations were organised finally as wireless sections, forming part of the Signal Company with an Army H.Q., Army Corps, H.Q., or Divisional H.Q. Provision was made for the repair of instruments and the charging of accumulators with each of these units and in the end our wireless equipment was more than adequate.

(To be continued.)

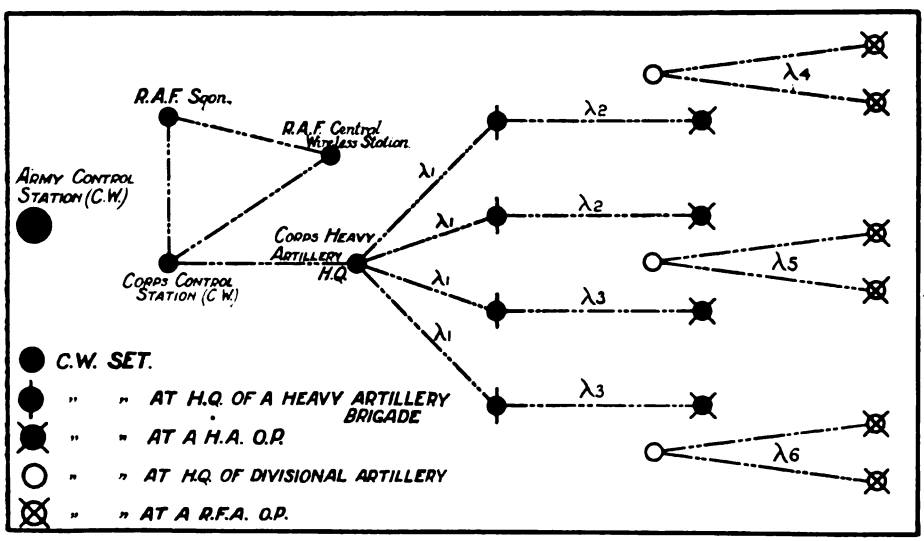

Fig. 3.

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Stray Waves

WAR TIME DEVELOPMENTS OF THE NAUEN STATION.

AT the beginning of 1914 this important German wireless station made use of 100 K.W. in the aerial with a musical note quenched-spark type of transmitter. After the outbreak of war the Sayville Station in America was called upon to handle an increasing volume of traffic. The original power of Sayville's apparatus was 35 K.W., but in 1915 a 100 K.W. high-frequency alternator was installed, enabling the traffic to be increased from 1.33 million words in 1915 to 2.58 million words in 1916. A further increase in power at Nauen then became necessary in order to overcome difficulties of working through atmospheric disturbances.

Two large antenna systems are provided—the larger being of T-shape, and the smaller in the form of an elevated horizontal triangle with the down leads from the apex. Simultaneous transmission on two different wavelengths is thus possible. The two main masts, of lattice construction, are 260 metres high, and are bedded on an insulating ball at the base. Additional insulation is provided at 150 metres from the ground. The supply alternator, single phase, can deliver 800-h.p., and after multiplication of the frequency by static frequency raisers, furnishes 24,000 ~ current to the aerial. The wavelength is thus 12,500 metres. Transmission at 200 letters per minute can be carried on. The overall efficiency is claimed to be 65 per cent. from alternator to aerial at 12,000 metres wavelength.

The following table gives an interesting comparison with the installation in use in 1908:—

	1908	1918	
		Small Aerial	Large Aerial.
Masts	1 of 100 m.	2 of 150 m. 1 of 135 m.	2 of 260 m. 4 of 120 m.
Antenna area sq. metres	31,000	77,500	155,500 sq. m.
Primary output K.W.	50	175	600
Aerial energy K W.	12	100	400
System	slow spark	quenched spark	H. F. Alternator C. W.
Range Kms.	3,600	8 000	20,000

* * *

THE CYLINDRICAL ANODE.

We reproduce below a letter addressed by Mr. Godfrey C. Isaacs to *The Electrical Review* which appears in the issue of that journal for August 8th.

"In the very interesting article, 'Vacuum Valve Amplifiers,' published in your issue of June 27th last, you state that the vacuum-valves for the wireless telephone sets employed by the British service are 'based on the invention of Mr. O. B. Moorhead, of San Francisco, who holds an American patent for the cylindrical anode.'

"In connection with this I should like to draw your attention to the fact that my company was the first to introduce the cylindrical anode.

"Already in the first valve patent No. 24,850, of 1904, by Dr. J. A.

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Fleming, the anodé is shown in the drawing, and described in the specification as a cylinder.

"In so far as valves for generating purposes are concerned, my company's patent No. 28,413, of 1913, by H. J. Round, contains the following claim:

"'A vacuum tube containing a hot filament, a grid formed as a closed cylinder surrounding the filament, and *a third electrode in the form of a cylinder* surrounding the grid.'

"You will notice that Mr. Round's invention dates back to a time when the use of valves for generating was quite a novelty, and I do not think that Mr. Moorhead's patent (which, I believe, has not yet been published) could have been applied for at an earlier date.

MARCONI'S WIRELESS TELEGRAPH CO., LTD.
(Sgd.) Godfrey C. Isaacs,
Managing Director.
London, August 1st, 1919."

* * *

THE SOLAR ECLIPSE AND WIRELESS TRANSMISSION.

As a result of certain observations made during the solar eclipse of May 29th last, further evidence is forthcoming with regard to the phenomena of day and night wireless signalling. Under normal conditions the wireless station at Meudon, Paris, is unable to receive daylight signals from Ascension, but can do so during the hours of darkness. During the eclipse, which was not visible in France and only partially visible in Ascension, special tests were made between the two stations, and it was found that whilst the moon's shadow passed between them Ascension was quite audible at Meudon, the signals failing as the shadow passed away. This may be taken as additional proof that the increase in the distance at which a given transmitter is able to affect a given receiver as a result of nightfall, is due to the diminution of the effect of solar radiation on electro-magnetic waves.

* * *

SIDELIGHT ON THE NEW W/T BILL.

The Somerleyton Merchant Shipping (Wireless Telegraphy Bill) enacts that vessels of 1,600 tons and over shall be fitted with wireless apparatus. Smaller vessels are exempted and one can only conclude that the Government has paid more attention to the outcries of the owners of the coastal shipping than to the basic idea that it is worth while preserving human life—anywhere. One day ship-owners will be compelled to provide every possible precaution against loss of life, just as are factory-owners; meantime seamen wrecked on small boats must swim for it. We note that the Grimbsy trawler, *Sun Cloud*, is supposed to have been lost with all hands in the North Sea, and that if such is the case her crew of ten leave behind them sixty-six children. *The Sun Cloud was not fitted with Wireless.* We seem to smell strikes amongst seamen, especially trawler fishermen.

* * *

In the article entitled "The New Wireless Service on the Island of Borneo," published in our August number, the author states that up to last year the Indo-Malay Archipelago did not possess any radiotelegraph station. It should be pointed out, however, that the Sandakan and Jesselton stations were working as far back as 1913, and those at Tawao and Kudat since 1915, all having been of much Imperial and local utility.

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Wireless Telegraphy Problems for Operators

By W. H. Eccles, D.Sc.

This is the concluding portion of the article specially written by Dr. Eccles for intending competitors in our Competition for Commercial Wireless Operators.

(See page 330 of September Number.)

Variations Due to Geographical Features.

OF these there are two kinds which we may say have been widely accepted as genuine; these are land shadows and, second, the easy transmission along river valleys. On both these more information is wanted. Land shadows are perceived in several ways. For example, a ship on the Cape route, when rounding the great bend of West Africa, gradually brings land between various European stations and itself. The problem of measuring the change in signal strength produced by this cause is complicated by the fact that the ship's distance is also increasing. However, this can probably be allowed for if a sufficient number of observations are made on successive trips. Other land shadows are produced by mountain ranges and should be observed and measured up. There are obvious practical applications here in the way of determining the power of a station for a new job.

The valley phenomenon is the converse of the shadow. For example, the Eiffel Tower Station is said to be received better in parts of the Mediterranean when the waves find their path lies down the Rhone valley than when they have to pass over even slightly hilly country. The Mississippi valley is said to have the same effect.

The whole question of how much better transmission is over water than over land is still open for the experimenter. Any voyage through the Mediterranean gives opportunities for examining the matter, and similar opportunities must often arise on other voyages.

The Problem of the Directive Aerial.

A problem that calls for investigation is: How far do the directive properties of such an aerial as that at Carnarvon persist? Theorists have argued that at a very great distance the strength of signals should be equal in all directions; the writer's own observations on various Atlantic trips show that the directive properties are decidedly pronounced at distances of several hundred miles. But much more investigation is needed.

Apparatus for Measurement of Variations of Signals.

It is obvious that the results obtained from any of the above suggested observations will be the more valuable the more quantitatively they can be made. One way of measuring signal strength is by the shunted telephone method. This is very rough and very frequently does little more than esti-

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mate the variations of the sensitiveness of one's own detector and hearing. The writer has used in preference the following simple method, which evolved itself gradually from a much more complicated collection of apparatus during a voyage across the Pacific when one part after another went wrong and could not easily be properly repaired. It gets over the difficulties which arise out of possible variations of sensitiveness of the receiving apparatus, and of the operator's ears.

The circuits are explained by Fig. 1, where A is the antenna, L a loading coil, M a small coil inserted in series with the antenna, and k the coupling coil leading to the detector circuits. The coil M is included in a circuit which can be impulsed to a variable extent. The variation is effected by having in the circuit a variable resistance R. Impulsing is done by means of a buzzer, which in the Figure appears to be of rather special kind because the contact it opens and closes is carried on a piece of insulation which separates the impulsing circuit completely from the driving circuit of the buzzer. The voltage for impulsing is supplied by two or three dry cells at E. When the buzzer is working, an interrupted current is sent round the circuit ERM, and at each break the antenna is set into oscillation. If spark signals are being listened to the buzzer ought to be made to give nearly the same note as the signals. Then if R is made big it will be found on pressing the key K that very weak sounds from the buzzer become mixed in with the signals being received. When R is made relatively small, strong sounds come to the telephones through the receiving apparatus from the buzzer when K is depressed. There is an adjustment of R at which the locally-made signals are

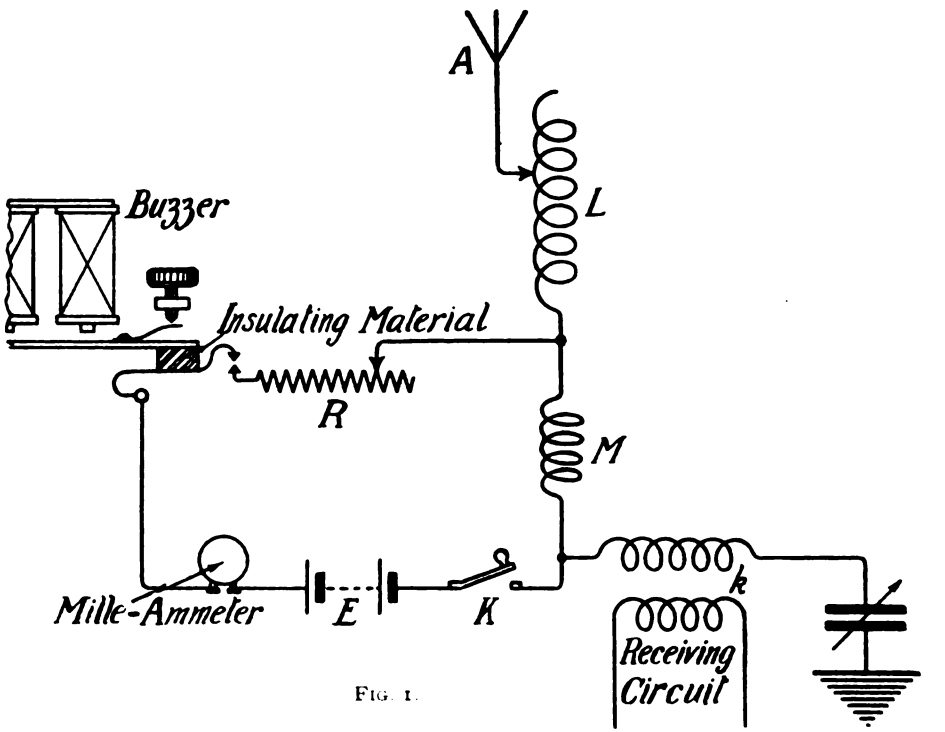

FIG. 1.

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equal in strength to the incoming signals. This matching of the sounds can be carried on in spite of the presence of strays, engine and water noises and conversation, features which cannot be claimed for the more frequently used shunted telephone method. The result obtained is chronicled by closing the vibrating contact and the key K for a few seconds and reading the milliammeter. I have found the best variable resistance consisted of a glass tube 18″ or 2 ft. long and $\frac{1}{4}$″ to $\frac{1}{2}$″ internal diameter, sealed at the bottom by a fixed cork through which a fixed electrode of copper wire passes into a 5 per cent. solution of copper sulphate nearly filling the tube. A second copper electrode enters the top of the tube through a perforated cork and can be pushed up and down so that its lower end can be immersed at different depths in the liquid. Better results are obtained if all of this conductor except about $\frac{1}{4}$″ at the lower end is covered with an insulating material. At sea the writer has used a piece of ordinary gutta-percha-covered wire straightened carefully as the variable electrode. At sea one makes in case of necessity further simplifications in the whole method; for example, if necessary, sea water can be used instead of copper sulphate for quick measurements. Then again the milliammeter can (if need be) be dispensed with by graduating the copper tube and recording the results of observation by measuring the lengths of the copper sulphate column used in balancing the sounds. At a pinch, one may even do without the buzzer, for one may impulse the antenna by drawing a piece of copper wire forming one end of the circuit across a fine file forming the other end of the circuit, so that the interruptions of contact thus produced give a note of about the pitch of the signals. The coil M inserted in the antenna need only be some 40 turns, 4″ diameter, of copper wire. These makeshift arrangements are not mentioned here to encourage observers to be content with makeshifts, but merely to show that lack of elaborate apparatus is no bar to making measurements of quite a reasonable order of accuracy in this branch of our subject.

The circuits suggested in the Figure are susceptible of many small changes without modifying their action; for example, the key K may if desired be put in the driving circuit of the buzzer so that the buzzer need not be kept going continually.

Observations of Strays.

Strays are natural electric waves travelling about the globe which seem to be classifiable into three types. The Radiotelegraphic Committee of the British Association gave these types the name "clicks," "grinders" and "hissing." When in mid-ocean one hears the "hissing" type one can be pretty sure of seeing, if it is daylight, a white squall within a few miles. This type is accompanied by continuous discharge down the antenna. It offers little opening for study except to operators interested in meteorology. The "clicks" have long been thought to be due to lightning discharges. Dr. de Groot, working in the Dutch East Indies, gives evidence for believing that the clicks originate in lightning discharges in the lower atmosphere. He claims also to have shown that the "grinders" are produced by electrical discharges in the upper atmosphere provoked by the bombardment of these upper layers by something from outside the earth. He puts these layers at about 100 miles high and thinks that any particular station receives its grinders from a comparatively small angular area vertically above it. In 1913 Mr. Ricci, a Marconi operator working for the British Association

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Radio Committee, brought home records from several round-the-world voyages showing that in the middle of every ocean when the distance from land was very great in every direction there were very few X's, either grinders or clicks, at any time of the day. This fact seems to indicate that Dr. de Groot's hypothesis is not acceptable in its entirety, for evidently cosmic bombardment ought to be quite independent of whether the observer is on land or at sea.

Again, everyone who has listened regularly in the telephones knows that X's grow rapidly worse as the ship approaches the edge of a Continent, and this more particularly if the land rises rapidly from the sea to great heights. No doubt the direction of the wind must have some bearing on these phenomena, for in all probability the X's are in this case largely due to the uprush of air that is always taking place on mountain ranges.

Conclusion.

The above paragraphs indicate broadly some of the main areas in which wireless investigation is needed. Having regard to the individual character of the researches contemplated in the present enterprise of the WIRELESS WORLD it is unnecessary, and is perhaps inadvisable, to lay down any definite scheme of work. By leaving everyone free to choose his own problem and his own method of attacking it, the fullest scope will be offered to originality, and discoveries may be made that might not have been embraced by any formal scheme. It may be encouraging to beginners to remark that in the actual carrying out of such investigations as are here contemplated the qualities of mind that count most are, probably, alertness, acuteness and accuracy of observation, together with judgment. Persons highly endowed with the above observational faculties can discover new features in old fields—features which when pointed out by the discerning mind become plain enough to everyone, including those who previously overlooked them. But judgment also is valuable, for without it the investigator is often finding something that really isn't there and is continually being tricked by his apparatus and his senses and being deceived by the wiles of Dame Nature.

COMPETITION FOR WIRELESS OPERATORS.

THE article written by Dr. Eccles, which is concluded above, throws out hints as to the manner in which commercial W/T operators may engage in wireless research work without interfering with their duties. Intending competitors should read pages 330-332 of our September number and decide upon what line of work they can best take up. The results of their work are to be submitted in the most appropriate form not later than January 7th, 1920. The prize-winners will be selected by Dr. J. Erskine-Murray and the joint editors of the WIRELESS WORLD, preference being given to the papers which are considered to be the most useful contributions to knowledge of the subject.

First prize, Twelve Guineas; second prize, Six Guineas; four consolation prizes, each consisting of Dr. Fleming's new book, *The Thermionic Valve and Its Developments in Radio-telegraphy and Telephony*, and Mr. Philip R. Coursey's *Telephony without Wires*.

Full details and the rules of the competition will be found in the September number.

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Notes of the Month

R.A.F. WIRELESS DEMONSTRATION.

ON August 11th a demonstration of Wireless Telephony was given by the R.A.F. in a Committee room at the Houses of Parliament. We understand that General Seely disclosed that the invention of continuous waves, and the valve in place of the coherer, made wireless telephony possible early in 1915. Somewhat earlier than that, we believe, —but what have the magnetic detector and the crystal done to escape honourable mention in respect of the evolution of detectors?

* * *

SOMERLEYTON WIRELESS TELEGRAPHY ACT.

On August 15th Royal assent was given by Commission to Lord Somerleyton's Merchant Shipping (Wireless Telegraphy) Act.

* * *

WIRELESS METEOROLOGICAL SERVICE.

An Admiralty Notice to Mariners (1393 of 1919), regarding wireless meteorological information to and from ships at sea states amongst other things that it is earnestly hoped that all concerned will assist in making the Wireless Meteorological Service a success. Negotiations are now in hand to extend and unify the system of collecting weather data by wireless from ships at sea all over the world, and to organise the free transmission of weather bulletins from a sufficient number of wireless stations to admit of ships being constantly supplied with reliable weather reports and forecasts wherever they may be. It is hoped that the messages will eventually be made in an International Code at fixed times so arranged that a ship with only one wireless operator will be able to read them.

The note previously appearing in regard to the British Stations at Poldhu and Cleethorpes to the effect that these stations " would be started shortly" is now deleted, and the stations are given as working. The station at Washington now issues bulletins at two fixed hours of the day instead of only one. New weather-reporting stations are notified as established at Annapolis, U.S.A., and for the Mediterranean at Binella.

* * *

WIRELESS STATION FOR WARSAW.

It is understood that the Polish Government is considering the establishment of a powerful wireless station near Warsaw and negotiations are being carried on with representatives of various nationalities, including American and German engineers. It is stated that the German Government has offered to construct the station for a figure some eight times lower than that quoted by other European countries.

* * *

WIRELESS AND METEOROLOGY.

Arrangements have been made to hold a conference of representatives of the Meteorological Services of the British Dominions in London from September 23rd to 27th.

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The subjects to be considered will include:—

(1) The meteorological arrangements for the exchange of observations by wireless at comparatively long distances. Specification of observations for the surface and the upper air, with the codes for transmission.

(2) The consideration of instruments and material for the investigation of the upper air.

(3) The selection of stations of the Reseau Mondial for the purpose of the general climatology of the globe. (See Reseau Mondial 1911-12-13, M.O. publication 207 g., 209 g., 214 g.)

(4) The provision of current meteorological information for the main air routes of the world; co-operation in the investigation of the meteorological conditions of aerial navigation.

(5) The Trade Routes and the meteorological survey of the oceans by observation transmitted by radio-telegraphy from ships.

* * *

WIRELESS CLUB NOTES.

The Wireless Society of London.

THE Committee of the Wireless Society of London met on July 24th under the Presidency of Mr. Alan A. Campbell Swinton, F.R.S., with a view to an early resumption of activities. The Hon. Secretary, Mr. R. H. Klein, having resigned, and having been elected an acting Vice-President, Mr. Leslie McMichael of 30 West End Lane, West Hampstead, N.W. 6, has been elected Hon. Secretary and to him all communications should be addressed. Intending new members, and those who were members at the outbreak of war who have changed their address, are requested to communicate with the Hon. Secretary.

The Society is at present in communication with the Post Office on the subject of licences.

The finding of new Club rooms is engaging the attention of the Committee, and it is hoped to secure premises where the wireless equipment of the Society can be installed and used.

A General Meeting will be held in a few weeks' time, of which due notice will appear in the Press and will be sent to members and those who anticipate becoming members.

We understand that the officials of the Society are in close touch with St. Martins le Grand on the question of licences. It will be remembered that before the War they appointed a strong advisory committee to assist the officials of the Post Office in sifting their numerous applications for licences and recommending those which should be accepted.

The Honorary Secretary informs us that the offer of their services has again been accepted in the same capacity Several questions in connection with the proposed new licences have still to be decided, particularly with respect to transmitting, but we gather that the genuine experimenter and the amateur, who is prepared to conform to reasonable regulations, may rely upon the Society doing all that can be done at the moment to further their interests.

* * *

Wireless and Experimental Association, London.

The Wireless and Experimental Association's meeting every Wednesday at 16, Peckham Road, S.E., at 7.30 p.m. is now in full session. As its name implies guidance is given to members who wish to construct their

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own apparatus. Lectures are arranged and interesting experiments are to be carried out. As soon as the P.M.G. can be persuaded that we have no designs detrimental to the Stability of the Realm or the Ether, we shall get our licences for working on a short wavelength, so keeping bright the skill which we acquired during the war and placed at the service of our country. "For we are all honourable men," and the land we defended against Teutonic aggression we now desire to decorate with graceful festoons of copper wire.

Mr. Gribble, the Secretary, will be pleased to receive applications for membership from all interested, welcoming more particularly ex-service men with experience.

* * *

Three Towns Wireless Club.

The report of the meetings of the above club during August is as follows:

August 15th.

Members of the Three Towns Wireless Club met at Plymouth Chambers. Mr. J. Jerrett was Chairman. It was decided to try and shake up our splendid Government re. restrictions on Wireless telegraphy for the so-called amateurs, many of whom were proficient enough to take charge of wireless installations in the Royal Flying Corps and in many other spheres when we were at War. Many of them desire to get on with their experimenting, now that they are no longer required. A protest has been sent to the P.M.G. and a hope was expressed that other clubs would follow suit.

August 22nd.

Mr. Voss gave an interesting and instructive lecture dealing with ether waves, sound waves, light waves and wireless waves. He explained how each kind penetrated various substances. The spectrum and X-rays were also dealt with. Mr. Jerrett, the Chairman, complimented Mr. Voss on his able address. It was also decided to hold a field day at Saltram Park, with Lord Morley's permission on Saturday, September 6th.

August 27th.

An interesting and instructive lecture was given at the Club headquarters by Mr. Lock on Detectors past and present. The oldest Detector is the eye. Then came mechanical ones, the Hertz Detector, Branly Coherer, Sir Oliver Lodge's Coherer, Marconi's Sealed Coherer, Marconi's Magnetic Detector, Various Crystal Detectors, Electrolytic Detectors, Fleming's Valve on which principal all the valves work up to the present day. All were dealt with in an able manner, and illustrated with models lent by Mr. J. Jerrett, and specimens brought by the lecturer himself. The lecture was thoroughly enjoyed by all present. A vote of thanks was given Mr. Lock for his kindness.

The Hon. Secretary will be pleased to see anyone wishing to become a member at 1 Brandreth Road, Compton, Plymouth.

Direct Wireless Service Between Holland and Dutch East Indies.

Stations are now in course of erection to provide for the direct transmission of wireless messages from Apeldoorn (Gelderland, Holland), and the Dutch East Indies, a distance of 11,000 kilometres.

* * *

The La Croix D'Hins Wireless Station.

This station which is in course of construction and which it is hoped will be completed within six months will be one of the most powerful in the world. The mast and aerial system will consist of eight steel masts 250 metres high and an antenna 1,200 metres long.

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Notes on Valve Amplification

By W. S. Barrell.

AFTER having briefly outlined the theory of valve rectification we will now proceed to deal with valve amplification. This important function is greatly utilized in up-to-date receivers, and has made long-distance reception much more practical and simple.

In pure valve amplification current variations in the grid circuit can be reproduced on a magnified scale in the anode circuit, and the following case is given as a simple example: In Fig. 1 is shown a step-up transformer S, the secondary of which has one end connected to the grid of the valve, the other end being connected to the potentiometer slider P; a pair of telephones is connected as usual in the plate circuit. Suppose a telephone to be connected to the primary of the transformer S and a watch laid on one of the earpieces. By correctly adjusting the position of the potentiometer slider magnified ticks will be heard in the telephone receivers. Here then is the case of the valve acting as an amplifier.

If the amplification given by the above scheme of connections is not sufficient it can be increased by adding another valve. The telephone receivers should be replaced by another step-up transformer, the secondary of which is connected to the second valve in precisely the same manner as the first one shown in the figure. The first would be styled a single and the latter a double amplifier.

The reader is now referred to the characteristic curves shown in Fig. 2. That the effect of current in the grid circuit is to damp out part of the oscillations has already been shown, and when used as an amplifier the valve should be worked at such a point that the grid current is zero. Reference to Fig. 2 will show that between the points A and B, although current is flowing in the anode circuit the grid current is

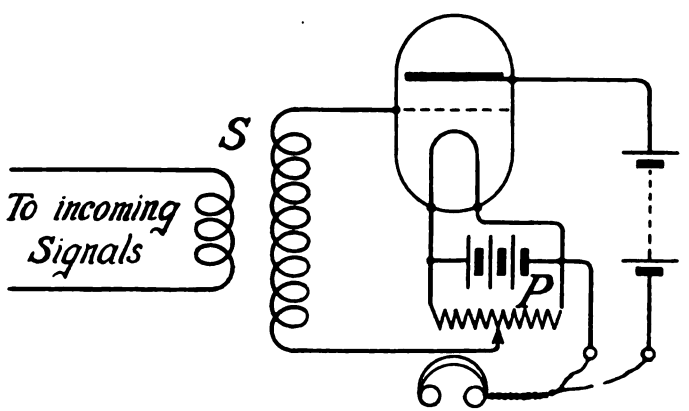

Fig. 1.

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zero. For amplification, then, the valve must be worked somewhere between these limits. Suppose the normal grid potential to be adjusted to the point C. Variations in the grid circuit will cause similar but amplified variations in the anode circuit, or, in other words, the conditions in the grid circuit are repeated on a larger scale in the anode circuit.

The anode-current-grid-voltage curves shown in Fig. 2 will now be studied a little more closely. Commencing, first, with the lower one, and, assuming that we are working with a normal grid voltage C a given voltage variation about this point produces a certain variation in the anode current. Working at

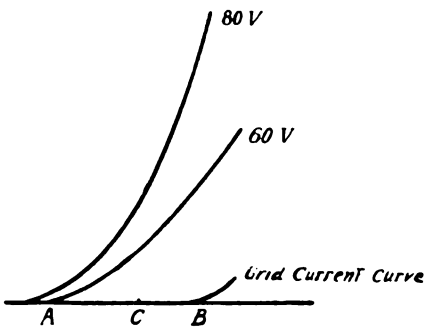

Fig. 2.

the same point on the upper curve it is seen that the same voltage variation produces a much greater anode current variation. That is to say, the steeper the curve the greater the change in the anode current for a given change in grid voltage. Now Fig. 2 shows that the characteristic is steepened by increasing the plate voltage, other things remaining constant. Theory therefore indicates that the magnification should increase with an increase in plate voltage, and Fig. 3 shows how this is borne out in practice. It will be seen that up to a certain point the magnification increases with increase of anode voltage, finally reaching a steady value, after

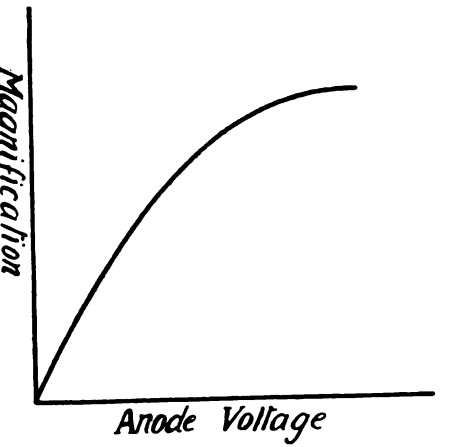

Fig. 3.

which an increase in plate voltage produces but little increase in the amplification. That the magnification is also a function of the filament current would also be expected since the slope of the anode characteristic depends upon the filament current, other things remaining constant. Fig. 4 shows how this assumption is confirmed by practice. In this case filament current has been plotted as abscissæ and magnification as ordinates. It will be noticed that the curves in Figs. 3 and 4 are similar in shape, both rising very rapidly at first, finally approaching a steady value.

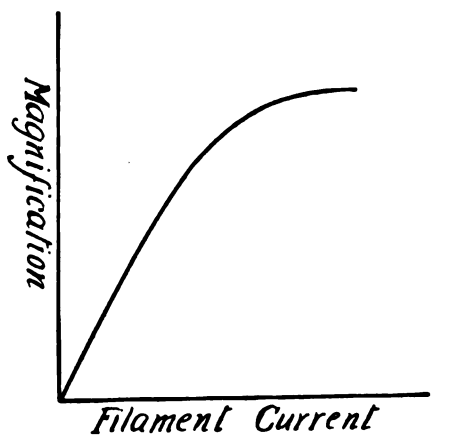

Fig. 4.

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NOTES ON VALVE AMPLIFICATION.

The magnification given by any valve is, of course, primarily dependent upon its design and mechanical dimensions, but for any valve the optimum magnification possible can be obtained by careful adjustment, as is seen by the curves in Figs. 3 and 4.

The amplification of any particular valve can be easily determined as follows: First, draw the ordinary anode-current-grid-voltage characteristic curve using the value of plate voltage it is intended to employ in actual practice. Determine the slope of the curve at the normal grid voltage to be used. This will give dI/dv which we may call X. Now draw a curve plotting anode current against *anode* voltage. The grid voltage must, of course, be kept constant and should be the same as that at which the slope of the anode characteristic curve was taken. The slope of this second curve $= dI/dV = Y$. and $\frac{X}{Y} =$ maximum voltage amplification.

THE BRITISH ASSOCIATION.

The annual meetings of the British Association have now been resumed after a lapse of three years, in the gathering held at Bournemouth from September 9th to 13th.

The inaugral address by the President was delivered by the Hon Sir Chas. A. Parsons, K.C.B., M.A., D.Sc., F.R.S., and dealt with a number of interesting points in connection especially with wartime developments in various branches of Science and Engineering. Particularly interesting details were given of the energy involved in various forms of artillery warfare; and in the large increases in the sizes of modern machinery. In the Engineering and Physics Sections of the meeting several papers were presented of particular wireless interest. Among these may be mentioned:

"Directional Wireless, with special reference to Aircraft," by Capt. J. Robinson, R.A.F.

"Wireless in the Royal Flying Corps," by Major Vincent Smith, M.C.

"The Three-Electrode Thermionic Valve as an Alternating Current Generator," by Prof. C. L. Fortescue.

"The Thermionic Valve as a Trigger Relay," and "The Use of Thermionic Valves in Parallel," by W. H Eccles, D.Sc., and F. Jordan, B.Sc.

In addition to these there was an important discussion on the use of Valves, opened by Dr. Eccles.

In addition to the above the report of the Committee on Radiotelegraphic Investigations was presented to the meeting. In this report it was pointed out that owing to the continuance of wartime restrictions on wireless working, only a few statistical records were obtained, and from Colonial Stations only The arrangements made by the Committee for Radio-investigations during the Solar Eclipse of May 29th were also dealt with, and the chief features discussed.

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Aircraft Wireless Section

Edited by J. J. Honan (late Lieutenant and Instructor, R.A.F.).

These articles are intended primarily to offer, as simply as possible, some useful information to those to whom wireless sets are but auxiliary "gadgets" in a wider sphere of activity. It is hoped, however, that they may also prove of interest to the wireless worker generally, as illustrating types of instruments that have been specially evolved to meet the specific needs of the Aviator.

AIRCRAFT WIRELESS SETS.

Spark Transmitters.

IN addition to the No. 1 Transmitter, a considerable number of other spark sets suitable for use on or in conjunction with aircraft were evolved during the war by the R.N.A.S., R.F.C., and R.A.F. They mostly belong to the earlier period. In the later stages the great superiority of the valve as a generator, particularly for light-powered sets, together with the general advantages of continuous-wave transmission, led to its adoption in practically all the most modern aircraft installations. These will be dealt with in later issues.

Meanwhile a short description of one or two other Service spark sets may be of interest.

THE 55A.

This is a 2-kilowatt set and is one of the heaviest spark installations used for aircraft work. It was originally fitted to Hawker's machine, but unfortunately the alternator was burnt out during a preliminary test, and the set was still useless when the sudden decision to start was made.

A photograph of the set is given in Fig. 16, whilst the skeleton circuit diagram, Fig. 17, shows the open and closed oscillatory circuits and the coupling inductances.

The exciter, alternator, and rotary gap are mounted upon the same shaft, and are driven through gearing from the propeller shaft of the bus.

The exciter is a shunt wound 0.2 kilowatt, giving a direct current of 4 amps. at 50 volts, whilst the alternator is the 2 kilowatt Mark III type giving 500 cycles at 180 volts on a speed of 3,750 revolutions per minute.

A closed-core, oil-cooled transformer is used, taking 180 volts through the primary and giving 10,000 volts across the secondary.

The sliding coupling-inductances A,B, shown separately at the foot of Fig. 17, are contained in boxes, placed one over the other, and together with the transformer and condenser C are housed on the same bed-plate that supports the alternator.

The wavelength is adjusted between 150-550 metres by plugging-in on the coil B, the coupling between the open and closed circuits being varied by sliding the upper coil B over the lower coil A. For longer wavelengths, series loading inductances are inserted in both circuits.

A search light was fitted in the prim-

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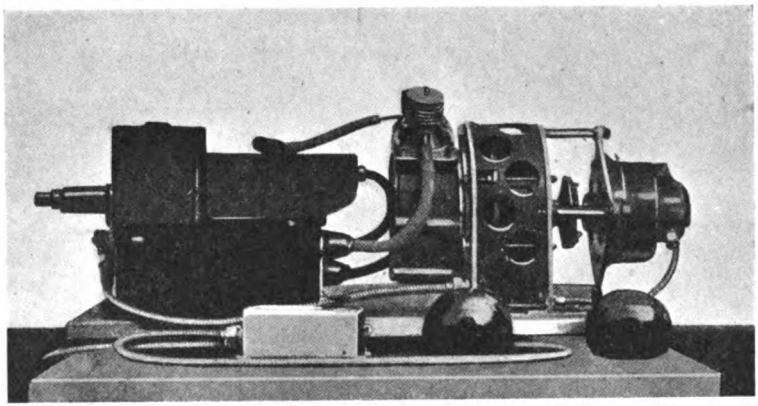

Fig. 16.

ary circuit of the set as used on active service.

Some of the chief points of interest in this set are set out under the following headings :—

ALTERNATOR.

The complete stator is mounted on Duraluminum supports bolted to the end plate.

The rotor has eight poles wound in series and all in the same direction. The spider and pole pieces are all of mild steel, the latter being cast separately and bolted to the spider. Intermediate pole pieces are placed between each of the main poles, and are bridged by pieces of mild steel.

A leather driving-ring is bolted and soldered to the outer flange, and is also bolted to the driving spider on the exciter shaft, the whole forming a universal coupling.

The brush gear comprises two brushes set at 180°, an even pressure on the slip ring being secured by two light springs. The complete gear is mounted on a floating frame carried by loose links which must be reversed before running the machine anti-clockwise as otherwise they are liable to jam and be damaged. For this reason the rotor pulley should always be turned clockwise when making a preliminary test before starting up.

If it is desired to run on reverse, the field leads to the brushes on the exciter must of course be changed over.

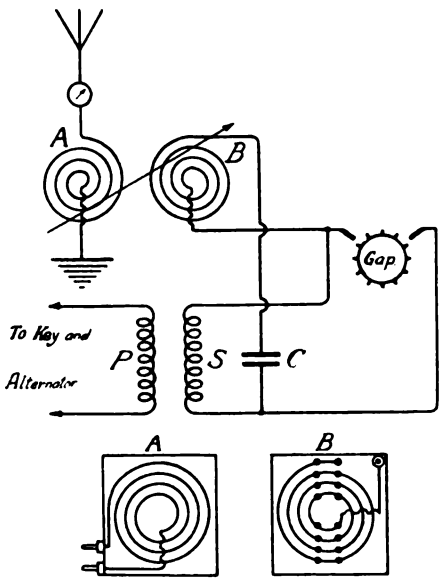

Fig. 17.

SPARK GAP.

This is enclosed in an aluminium casing pierced at the front and sides, the apertures being covered with fine copper gauze in order to afford ventilation

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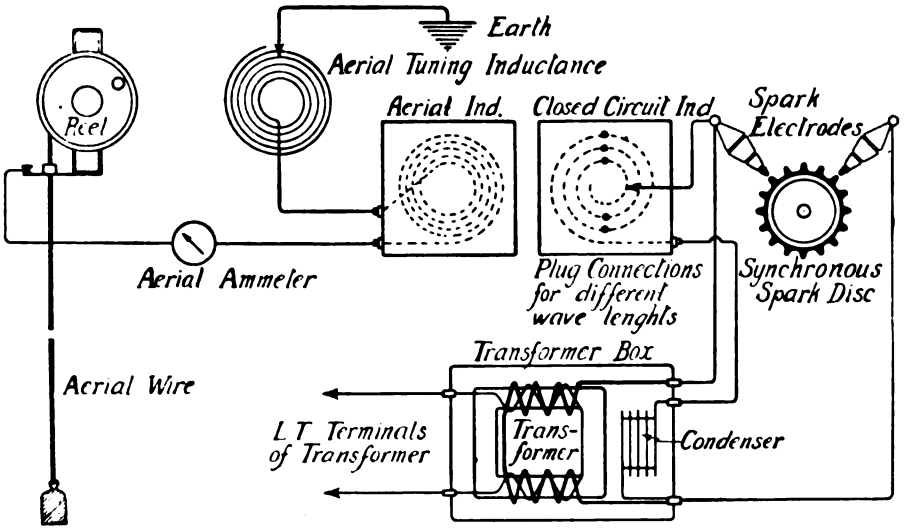

Fig. 18.

while minimizing the danger of fire in an atmosphere that may be highly charged with petrol—or, in the case of airships, that may comprise a highly inflammable admixture of gas.

The spark gap distance is adjusted by turning the outermost nut over the cooling-fins. The rotary disc has 16 spark points. As it is mounted on the same shaft as the 8-pole alternator synchronism is ensured.

Before starting up the arrows on the end plate of the alternator and spark box should be in register. If not, they must be aligned by turning the phase adjuster accordingly. A special key is provided for this purpose.

KEY BOX.

The key box is fitted with two switches. One closes the exciter circuit to energize the set, and the other controls the searchlight, which is inserted in the primary circuit from the alternator. A direct-current ammeter is mounted over the box to indicate the current in the exciter circuit.

TRANSFORMER BOX.

This contains the closed-core transformer and the condenser. The side of the box is fitted with five oil-tight brushes through which the leads pass. The whole is filled with oil. The condenser is clamped to the inside of the box, the securing-bolts being filled with rubber washers where they pass through the sides of the box in order to prevent leakage of oil.

WEIGHT AND RANGE.

The total weight of the set is approximately 90lbs. Its range with maximum coupling and crystal reception is about 300 miles under normal conditions.

Fig. 18 is a schematic diagram of the windings, omitting the alternator and exciter.

(To be continued.)

AEROPLANE WIRELESS RECORD.

In connection with the recent transatlantic flight of the American seaplanes, it is interesting to note that a transmitting range of 1,800 miles from the aeroplane to the ground station has been claimed. This constitutes the longest distance officially transmitted from an aeroplane to the earth.

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Aviation Notes

THE COMMERCIAL ASPECT.

THERE are many indications that, before long, aviation will be firmly established in the Commercial field as an active competitor with existing Transport Services.

A regular daily service for passengers and light goods has already been inaugurated between London and Paris by the Aircraft Transport and Travel Company controlled by Mr. Holt Thomas, with whom General Sir Sefton Branckner (late R.A.F.), is associated.

Mr. Holt Thomas intends to maintain this service throughout the winter, and hopes to secure a ninety per cent. efficiency. Only dense fog or exceptionally bad weather will be allowed to interfere with the daily flights.

Photo by Topical Press

MR. HOLT THOMAS.

Photo by Sport & General

GENERAL SIR SEFTON BRANCKNER.

The scheduled time for the journey is just over two hours, and the passenger fare is at present twenty guineas per head for the single trip, with a 10lb. allowance of personal luggage. Individual parcels can be sent at the rate of 7s. 6d. a lb., but regular deliveries over a stipulated period are accepted at half-rates. A widespread collection and delivery scheme is in operation in both capitals in connection with the parcel traffic.

The same Company also proposes to institute a regular Folkestone-Boulogne passenger service for those who prefer a fifteen-minute flit in the air to the joys of spending an hour and a half on the ocean waves.

In addition the Handley Page Transport Company are running a daily service from their Cricklewood aerodrome serving Paris and Brusels on alternate days.

The first regular air way in this

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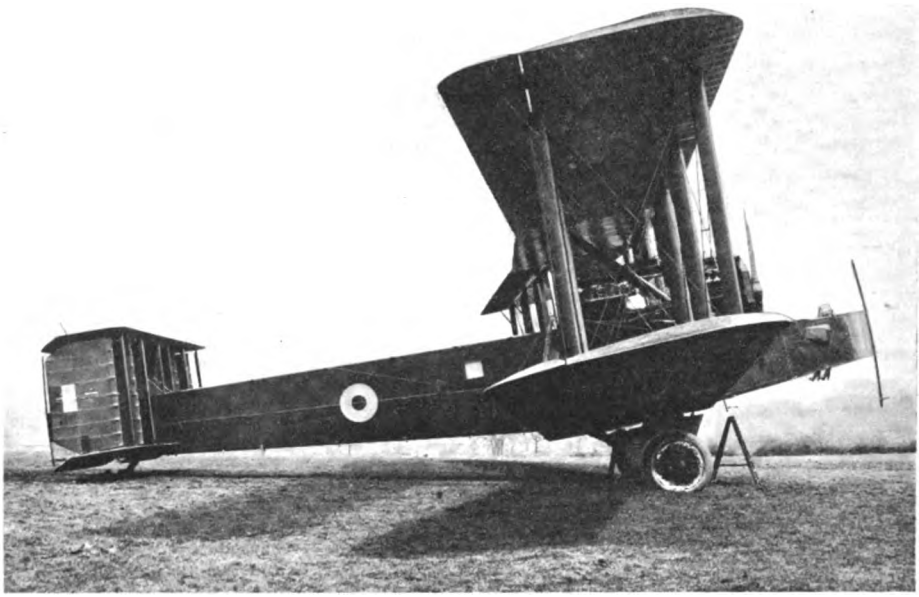

Latest type Handley-Page Machine as used for Commercial-flying.

country, the Stockport and Manchester-Blackpool route, was established some time ago by the Avro Company who claim to have transported over 20,000 passengers with a total casualty list of one minor accident. This Company advertises its willingness to carry individual passengers to Paris or anywhere else, but does not at present contemplate setting up a regular cross-channel service.

In its present stage of development the widest field of employment for the plane as an agent of general utility would appear to be offered by the Mail Service. The carriage of correspondence is, however, entirely under Government control and is, therefore, not a matter for individual commercial enterprise. But it is to be hoped that the Post Office will not long ignore a mode of transport that apparently affords a more expeditious means of communication between London and Paris than is to be secured at present by either the Telephone or Telegraph services.

To-day commercial aviation claims only the cream of the passenger traffic *de luxe* and occasional light parcels of urgent merchandise as its share of transport work. But existing difficulties and handicaps are being successfully tackled; initial cost, and upkeep and running expenses are being reduced;—in a word rapid strides of progress are being made. But a few years ago, the gas bag represented the only air-borne vehicle. A few years hence, and aviation may provide the means of forcing the Railway Companies, under the stress of competiton, to drop that extra fifty per cent. on passenger fares!

* * *

AVIATION IN GERMANY.

Over there they still believe in the Zeppelin. At present a daily service

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is being run between Berlin and Friedrichshafen on Lake Constance, a distance of 380 miles. The craft used is a small type of Zeppelin specially constructed for the purpose. It is about 400 feet long, has a capacity of 20,000 cubic metres, and can carry from ten to twelve tons. This type has the advantage that it can easily be handled, especially when being taken out from, or returned to, the shed; and it carries only a small crew. Four motors, developing 1,100 horsepower give a normal speed of 70 miles per hour.

The passenger cabin contains 20 easy chairs ranged 10 on each side, and can accommodate altogether 25 passengers. It is fitted with Wireless Telegraph apparatus, a lavatory with running water and a canteen where hot and cold food can be obtained. Altogether it seems to be able to give the average seaside boarding house points in general comfort and convenience. The fare is 400 marks (nominally £20) for the single journey and 30lbs. of personal luggage are carried free for each passenger.

* * *

BRITISH AIRCRAFT COMPETITION.

The Air Ministry announces that the Government has decided to offer prizes to the value of £64,000 in a competition open to the British Empire for the best submitted designs of (a) Aeroplanes, and (b) Seaplanes.

The aeroplane section is divided into two types, viz.: (1) small type with a total carrying capacity of two persons (including the pilot) and (2) large type with seating accommodation for 15 persons (exclusive of crew). The prizes offered for the smaller type are, 1st prize, £10,000; 2nd, £4,000; 3rd, £2,000. The Government also contracts if the competitor is willing, to buy the machine winning the first prize for £4,000, the designs remaining the property of the entrant. In the larger type the prizes offered are: 1st, £20,000; 2nd, £8,000, and 3rd, £4,000. The Government offers to buy the first-prize machine for £10,000 under the same conditions.

In the case of seaplanes the carrying capacity must be four persons, exclusive of the crew, and the prizes offered are £10,000, £4,000 and £2,000 with a purchase price of £8,000.

The competition opens on 1st March, 1920, and closes on December 31st of that year.

The principal object, as set out in the conditions, is to ascertain the type of craft that offers maximum safety in the air combined with the advantages of alighting in and rising from the minimum ground space.

The small type of plane must be capable of flying level with full load at or above 100 miles per hour and also at or below 40 m.p.h. For the larger type these speeds become 90 m.p.h. and 45 m.p.h. respectively. Climbing power, in the case of the smaller craft must be not less than 500 feet in the first minute from ground level, and 350 feet for the larger type.

* * *

GORDON SHEPHARD MEMORIAL PRIZES.

The father of the late Brig.-General G. S. Shephard, D.S.O., M.C., has placed, in memory of his son, a sum of money in trust, the income of which is to be applied to the provision of annual prizes for Essays on Airmanship open to Officers, N.C.O.s and men of the R.A.F.

The specified subjects this year are (1) Sea and Fleet Reconnaissance, and (2) Aerial Navigation and Pilotage.

The administration of the prizes is being carried out by the Air Council.

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WRECK OF THE "FELIXSTOWE FURY."

Probably the biggest air-craft in existence, the Porte flying boat—popularly known as the Felixstowe Fury—crashed at the very outset of a voyage that was planned to include the entire traverse of the African Continent from Alexandria, via, Khartoum, Tanganyika, Beira and Durban, to Cape Town. She had barely left the slips at Felixstowe harbour, and had risen only 10 or 15 feet, when the left wing dropped and caught the water. The vessel swerved round and almost simultaneously nose-dived into the sea.

She carried a crew of seven, all of whom were rescued with the exception of Lieutenant S. E. S. Macleod, the Wireless Officer, who unfortunately became entangled in the wreckage and was drowned before he could be extricated.

His name is yet another to be added to the list of gallant men of the wireless profession, who, in Peace as well as War, have made the supreme sacrifice in the interests of their calling and the demands of duty.

The boat was built under the supervision of Colonel Porte, and was of the triplane type. The span of the top planes measured 123 feet, length from nose to tail 60 feet, and height 27½ feet. She weighed 10 tons and could carry 30 passengers. Her set of five Rolls Royce engines were capable of developing 1,800 horsepower—sufficient to give her a speed of from 80 to 90 miles per hour under full load.

It had been intended to try her capabilities on the transatlantic flight, but her immense size rendered the question of transport on the outward journey to Newfoundland so difficult that the project was abandoned.

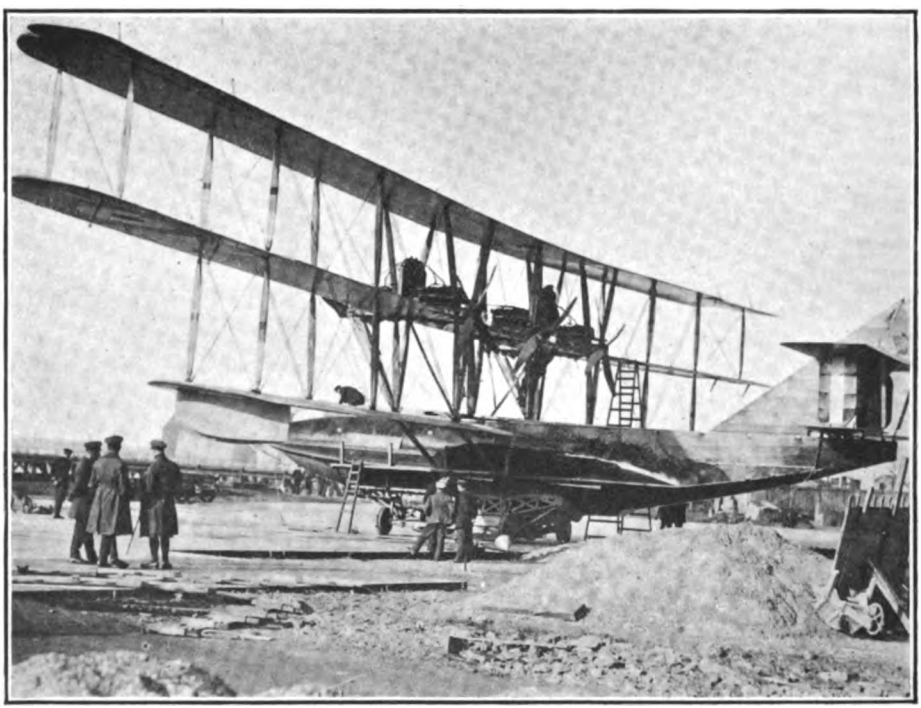

Photo by *The "Felixstowe Fury."* Associated Illustration Agencies Ltd.

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OFFICIAL DEMONSTRATION FLIGHT TO SCANDINAVIA.

With the specific object of demonstrating the advanced state of development of British aircraft, and the potentialities of flying boats for commercial purposes, an official tour of the Scandinavian countries organised by the Air Ministry has just been brought to a successful conclusion.

Flying boat, N.4044, was chosen for the trip, this type being considered most suited to the countries concerned. Very few land aerodromes exist in Norway, Sweden or Denmark, whereas sheltered stretches of water, forming natural " seaplane harbours " are to be found practically everywhere. There is undoubtedly a big commercial future for the right type of aircraft in these countries.

The development in Sweden and Norway in particular has, up to the present, been greatly hampered by the lack of sufficient transport facilities, owing to the distinctive geographical features of the Peninsula. The extended use of aircraft, on a commercially sound basis offers a promising solution to this difficulty. The point has not been overlooked by the Germans, who with characteristic acumen are already in the market, and offer both seaplanes and aeroplanes at unmistakably " cut " prices.

The N.4044 made an extended tour, visiting Christiania, Copenhagen, Stockholm and several intermediate towns. A total distance of 2,500 miles was covered in 40 hours of flying, in addition to numerous exhibition flights all without a single mishap.

During her stay at Christiania the boat came under distinguished patronage. Queen Maud of Norway made two trips in her and, on the second occasion, " took charge " for a short period.

The official report of the voyage lays particular stress upon the trustworthiness and usefulness of the wireless installation, which maintained communication with Dundee throughout the entire period of flight across the North Sea.

* * *

R34 ATLANTIC AWARDS.

The following honours have been awarded in connection with the voyage of the R34 across the Atlantic and back in July last:—

To be Commander of the Order of the British Empire—Major George Herbert Scott, A.F.C., commander of R34 on the voyage.

Air Force Cross.—Col. (A.-Brig.-Genl.) E. M. Maitland, C.M.G., D.S.O.; Capt (A.-Major) Gilbert G. H. Cooke, D.S.O; Lieut. Guy Harris, 2nd-Lieut. John D. Shotter.

Air Force Medal.—No. 206345, Flight-Sergt. W. R. Gent; No. 200965, Sergt.-Major H. W. R. Mayes, D.S.M.; No. 314353, Flight-Sergt. W. J. Robinson; No. 200079, Flight-Sergt. R. W. Ripley; No. 201741, Flight-Sergt. N.A. Scull; No. J./3349, Sergt. H. M. Watson, D.S.M.

* * *

DWINA RIVER EXPEDITION.

The conditions under which the R.A.F. seaplane flight lives on the Dwina River are somewhat novel, and their duties arduous both by day and through the semi-darkness of the Arctic night. Enemy vessels have been effectively bombed and machine-gunned; spotting for the guns of our river flotilla has been directed by wireless and photographic surveys regularly carried out. Doubtless, also, wireless has played an important part in locating the position of their moving home, which consists of a barge which moves up and down the river according to requirements.

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The Library Table

THE PRINCIPLES OF RADIO-TELEGRAPHY.

By CYRIL M. JANSKY.

London: The Hill Publishing Co., Ltd. Pp. ix + 242. 179 illustrations. 10/- net.

THERE are eleven chapters in this book, but not until the fifth is reached does the reader come to the subject of wireless telegraphy. The first four chapters deal with magnetic and electro-static phenomena, electromagnetism and units of measurement, after which there are twelve pages about electromagnetic waves. We do not understand why the last-mentioned chapter is followed by a discussion of elementary alternating currents; surely the student should have a sound acquaintance with these phenomena before he attempts to grapple with the problems of aether waves. Some twenty-three pages are devoted to oscillatory circuits and a further twenty-eight to "radio circuits," a term which the author employs in order to indicate that he refers to oscillatory circuits capable of producing electromagnetic waves. The book concludes with three chapters on transmitting and receiving appliances and vacuum tubes.

In spite of certain defects to be mentioned later, the work under review is a useful addition to the ranks of books on wireless telegraphy intended especially for the beginner. The diagrams are very well drawn and the half-tone reproductions quite up to the average, with the exception of that illustrating on page 108 the oscillatory discharge of a condenser. Writing in general of half-tones, and in particular of those which show the exteriors of the apparatus, we have long questioned their value in text-books of this nature. For example, in this book the British reader sees photos of apparatus made only by American firms and which he will in all probability never meet in practice.

True to what is promised in the preface the treatment is not mathematical beyond the standard of the average reader, and is rendered more luminous by a number of worked examples, aids which are so often lacking in otherwise excellent books.

There is evidence of hasty writing and hasty correction in this work and for the sake of future editions we must point out the following defects:—

(1) On pages 4 and 5 the blocks are evidently transposed and the explanatory text is not at all clear; for instance, on page 4 there is the statement that if the two magnets shown in Fig. 2 were allowed to swing freely in a horizontal direction, the two ends near each other would point in opposite directions. Yet the two ends are *like poles*. A great deal of the confusion of paragraphs 4 and 5 would be cleared up by putting the blocks in their right places.

(2) In the chapter on units the gramme is defined as the 1/1000 part of a mass of metal called the kilogramme. We know quite well what the writer has in mind, but we do not think his definition is a happy one. On page 39 there is a reference to an acceleration of "1 centimetre per second."

(3) On page 69 there occurs the surprising statement that by wavelength is meant the distance the wave advances in one second.

(4) On page 80 velocity is defined as

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the time rate of motion in a specified direction; and the third property of velocity, *sense*, is ignored.

(5) On page 93 we read that if a condenser has one of its plates connected to both sides of a battery circuit, it will become charged. What is supposed to be done with all the other plates? In any case these should be metallic plates, though this is not made clear in the first line of the chapter on oscillatory circuits.

(6) On page 109 it is said that the discharge of a condenser is a process by which the potential energy of the charge is dissipated gradually in heat. Not always all of it, luckily for wireless telegraphy.

(7) In his definition of the antenna the author implies that the latter includes the A.T.I. the jigger secondary, a variable condenser and the earth system. Why not complete the list by including the hot-wire ammeter?

There are a number of misprints scattered throughout the book. It might also be remarked that the diagram on page 114 is not the best introduction to an oscillatory circuit that a student of wireless telegraphy could have, and that the practice of connecting the transformer across the transmitting condenser, as shown on page 160, is being abandoned. British readers will no doubt find rather confusing the use of the terms abvolts, abcoulombs, etc., and also the employment of the word Gilbert for magnetomotive force.

* * *

"THE THERMIONIC VALVE IN RADIO TELEGRAPHY AND TELEPHONY."

By Professor J. A. Fleming, M.A., D.Sc., F.R.S.

London: The Wireless Press, Ltd. Pp. xv + 280, Price 15s. net.

It seems singularly fitting that Dr Fleming, who took the first step in the utilization of Thermionic valves in Radio-telegraphy should also be the first British author to write an advanced comprehensive treatise on this all-important subject. Such a treatise will be welcomed for two reasons. In the first place, a large number of the original papers on this subject are only to be found in British and Foreign scientific papers, and are thus not conveniently accessible to many workers, and, secondly, the assimilation of all the salient results of these papers in a single volume will do much to standardize the nomenclature of the subject. The second reason is almost as important as the first for the tendency of radio workers to multiply new terms and names needlessly (a proclivity developed in America to the highest degree) can only produce a harmful confusion.

The first chapter contains an historical account of the subject of Thermionics and Electron Theory in general. A knowledge of the fundamentals of this subject is a *sine quâ non* for all students of Radio-telegraphy who wish to understand thoroughly the action of a valve and its many appplications. In reading this chapter one realizes how much we are indebted to workers in pure science (in particular to Sir J. J. Thomson and Prof. O. W. Richardson) for the large amount of information available about the ubiquitous electron. The second chapter deals solely with the Fleming valve and its applications, the subject being dealt with both from qualitative and quantitative standpoints. It is interesting to note that the first explanation of the action of the space charge is here attributed to C. D. Child and not to I. Langmuir as so many previous writers have done in error. The result of the famous Marconi and de Forest suit in

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the United States Court of Appeals (which, of course, is now scientific history) is here given, while the full text of the pronouncements of Judge Mayer are given as an appendix to the book. The latter half of this chapter is devoted to the technique of the commercial methods of producing high vacua. Here we are reminded of one of the most flagrant cases of the needless multiplication of names. The "Kenotron" of Dr. Dushmann is nothing more than a high vacuum Fleming valve. That Fleming nearly fifteen years ago recognised that a valve of extreme exhaustion would be a perfect rectifier is clearly shown by his remarks (not quoted in the book, however,) to the Royal Society in 1905 when he said, "An ideal and perfect rectifier for electrical oscillations may therefore be found by enclosing a hot filament and a cold metal anode in a very *perfect* vacuum."

The next two chapters are devoted to the Three-Electrode Valve as a detector and generator respectively. The original and suggestive work of E. H. Armstrong is fully described, and an interesting application of Maxwell's cyclic method of solving electrical problems is given, treating a valve and its circuits as an electrical network. The first discovery of the generating properties of the three-electrode valve is attributed to Meissner, though it appears to have been independently discovered later by Armstrong and also by Franklin and Round.

The last two chapters deal with the numerous applications of Thermionic valves in Radiotelegraphy and Telephony and include a thorough discussion of almost all ordinary circuits. One notable omission appears to be that no mention is made of the very common use of an alternating source of high potential, with hard Fleming valve rectifiers, for the plate voltage of transmitting valves. The simple mathematical theory of the three-electrode valve is fully worked out, the results of Vallauri and Van der Bijl being summarised. It is on similar quantitative lines that the progress of valve design will be made.

This volume can confidently be recommended to the general physicist (who is indebted to the special subject of wireless for the development of such an invaluable laboratory instrument) as well as to radio workers, as a concise and lucid digest of the subject up to the present.

E. V. APPLETON.

* * *

USEFUL NOTES ON WIRELESS TELEGRAPHY.

By H. E. PENROSE.

London: THE WIRELESS PRESS, Ltd. Books I.—V., 1s. 4d. each net.

Book I.—Direct Current, pp. 65.

Book II.—Alternating Current, pp. 50.

Book III.—High Frequency Current and Wave Production, pp. 66.

Book IV.—The Marconi 1½ kw. Ship Set, pp. 77.

Book V.—The Oscillation Valve, pp. 53.

These booklets have been written with the object of presenting to students a brief resumé outlining the general principles underlying the transmission and reception of wireless signals. Their purpose is to act as guides to indicate the ground to be covered in other standard wireless text books in order to obtain a working knowledge of modern wireless apparatus.

Throughout the text a number of references are given to electrical and wireless text books, where more complete information on the details or apparatus under consideration can be obtained.

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The first booklet of the series commences with an elementary consideration of the electric circuit, and then leads up to a consideration of accumulators, direct current generators and motors.

In the second, the ideas of varying and alternating current are introduced, together with the effects of condensers, inductances and of resonance. The alternator, Rotary - Converter and Transformer are also dealt with.

The third booklet brings in matter of a more particularly wireless nature with the consideration of H.F. currents and of types of waves, leading to a description of simple transmitting and receiving systems.

The fourth book deals entirely with particulars of the Marconi Ship Sets, with operating arrangements, and in particular concludes with an important chapter on fault tracing.

The fifth booklet is of rather a different class. It treats of the oscillation valve, commencing with the conduction of electricity through gases and a description of the Fleming rectifying valve. From this the ideas of the 3-electrode valve are introduced and various circuit arrangements described, including several arrangements of multi-valve amplifiers and means for the reception of continuous wave signals. This last booklet should be of special use to all students desiring a closer acquaintance with the use of valve receivers.

* * *

ELEMENTS OF THE ELECTRO-MAGNETIC THEORY OF LIGHT.

By L. Silberstein, Ph.D.
Longmans, Green and Co., 3/6 net.
(Pp. 48.)

This little book has been re-written from the author's larger (Polish) treatise on Electricity and Magnetism. The contents in particular cover the ground of Ch. 8 Vol. 2 of that work with slight additions and modifications. The author traces the development of the electromagnetic theory from the original proposals of Clerk Maxwell in 1865, and quotes the various reasons that have led to its general acceptance. Before considering the vectorial equations of the theory in detail a summary is given of the "elastic" theories of light and of the difficulties that were experienced in endeavouring to fit these in with well-known experimental facts. These difficulties increased as the earlier theories became more fully developed, and are quoted in the book to show up the superiority of the electromagnetic theory in explaining such phenomena. The classical experiments of Hertz served in their turn but to strengthen the development of this theory.

As the fundamental theory of all wave-propagation through the aether, a proper understanding of at least its leading features is of the utmost importance to all workers in the radio field. To them, therefore, and to all students of this subject, this little booklet should make a powerful appeal, as it puts forward the chief points and equations in a handy form, thus dispensing with the necessity of abstracting the desired information from a large mass of abtruse mathematical reasoning amongst which it is customarily buried.

After the initial exposition the author concludes the book by discussing the general formulæ and theories relating to the optics of crystalline media, and of the velocities of wave-propagation along the various axes of crystals.

A number of references are given to original publications, dealing with the development of the various theorems, which should be of use to workers in this field.

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Personal Notes

U.S. WIRELESS MEN WIN DECORATIONS.

MAJOR - GENERAL GEORGE O. SQUIER, the well-known U.S. Army Wireless Expert, has been decorated with the Order of Knight Commander of St. Michael and St. George. The ceremony was performed by Earl Haig.

Mr. C. F. Elwell, Consulting Radio Engineer, has been awarded the Cross of the Crown of Italy. Mr. Elwell erected a Wireless Station at Rome.

* * *

NEW CHIEF ENGINEER AT G. P. O.

Mr. W. Noble, late Assistant Engineer-in-Chief of the London District for the Post Office, has been appointed to succeed Sir W. Slingo as Engineer-in-Chief at the G.P.O. Mr. Noble entered the G.P.O. in 1877 and served as Telegraphist in the Aberdeen Post Office; thus he has worked his way up to the present position from the bottom of the ladder.

* * *

SOME DANCE!

Old students of the Atlantic Wireless College, Cahirciveen, will be interested to hear that the annual dance was held in the Carnegie Hall on Tuesday night, August 26th. Dancing *commenced 10.30 p.m. and lasted until 7 a.m.* Over 200 guests were present, and a very successful evening was passed, due largely to the efforts of Mr. M. F. Flattey, the Secretary of the Committee.

LADY WIRELESS OPERATOR AND HER SHIP.

Miss M. Alsen,

Wireless Operator on S.S. Jupiter for several voyages.

S.S. Jupiter.

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DEATH OF LIEUT. McLEOD.

Photo by G. Vandyke, Ltd.

LIEUT. S. E. S. McLEOD.

We much regret to record the death of Lieut. S. E. S. McLeod, late Wireless Officer of the "Felixstowe Fury," the famous Porte flying boat, which met with disaster just after starting for the Cape *via* Egypt on August 11th. Lieut. McLeod, being fastened in his seat, was unable to extricate himself from the wreckage and was drowned.

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Correspondence

AN OPERATOR IN MESOPOTAMIA.

SIR,

Whilst working in Mesopotamia last October, I had rather an interesting experience with jambing.

We had two stations within six hundred yards of each other. D was equipped with a ½-K.W. Marconi pack set and had an inverted L aerial with a directional effect towards the N.E. U was an umbrella aerial used for listening in only. About 3 miles S.E. of D there was another station having no connection with our work. We worked on 300 metres at D and this other station worked on 600 metres. Before U was erected we worked D and had no complaints from this other station about interference, we were sharply tuned and you will observe our directional effect N.E. would be such as to cause minimum interference with this station to the S.E. Yet directly U was erected complaints of jambing came in at once. After a time I was forced to the conclusion that D station caused forced oscillations in U and this aerial being an umbrella acted as an auxiliary transmitter with, of course, all round directional effect. In any case, on our lowering U aerial during transmission from D, we received no further complaints. One could actually get loud signals by merely connecting one end of the phones straight to U aerial and holding the other end, there being absolutely no connection with any instruments. Signals were best with a moderate pressure between finger and thumb, the rectifying effect is evidently here.

Yours truly,
C. R.

SIR,

I was interested to see in your April number reference to the charging up of aerials on board ship. I have had similar experiences in land work while in Mesopotamia, which might possibly interest you. On one occasion I was listening in on an 80-feet umbrella aerial near Hit in the Euphrates. There was no wind and no sign of a thunderstorm anywhere, whilst atmospherics were moderate. Quite suddenly, the aerial started charging up at a very rapid rate with the usual "sizzling" sounds of many brush discharges. I barely had time to short the aerial and remove my 'phones before a most violent rainstorm started, still without any thunder or wind. It lasted perhaps for five minutes, but it was the most intense rain I have ever witnessed, one could not see more than a few yards away. Unfortunately, I was too busy trying to save the apparatus to make further observations, but should probably have found, as in similar cases, the charging up of the aerial ceased as the rain started. I venture to think there is food for thought in this connection. This phenomenon is common when a thunderstorm is near-by, but seems strange when there is no sign of a storm before or after.

Needless to say, dust storms are the bugbears of operators. A bad storm will charge up an aerial to such an extent that the frequency of discharge from aerial direct to earth across a ½-inch gap has been sufficient to cause a musical note. It is interesting to hear this note vary with the strength of the storm.

From about October to March in Mesopotamia the winds are nearly always North or South. With the former are associated fine weather and few strays, but directly the wind gets to the South again, the atmospherics start, with bad weather. Incidentally, the wind was south round about Armistice Day, but we were able to pick up tantalising scraps from Europe!

I am, etc.,
C. H. E. R.

SIR,

The treatment of amateurs in trouble at the Courts since August, 1914, seems most unfair when looked at from the point of view of the *bona-fide* amateur, whose very sureness of his own harmless intents, made him in many cases somewhat careless of secrecy and contemptuous of possible consequences, vaguely rebellious in his heart against the petty restrictions of "red tape" which forbade him that relaxation of mind that meant so much to him, for even after a long day of war work the old hobby would still have been a welcome diversion of interest.

The feeling of the amateur was only intensified when he realized how inadequate the restrictions were to stop anyone who wanted, from receiving from most of the stations in the British Isles. An indoor aerial within reasonable distance of any station would give good results, quite enough for its purpose, with practically no danger of discovery.

Thus the amateur whose only desire was to increase his knowledge, was fined and imprisoned for daring to think of such a thing, while the path of the other sort of person was ridiculously easy.

It is hoped that the influence of some of our great scientists and others of note in the wireless world will avail to assist the Government to grant the amateur the facilities for work and study, for which his war service has in no small measure merited him.

With best wishes for the success of your excellent magazine,

Yours truly,
REG. G. H. COLE.

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The Construction of Amateur Wireless Apparatus

This series of Articles, the first of which was published in our April number, is designed to give practical instruction in the manufacture of amateur installations and apparatus. In the following article the author deals with the important question of THREE-ELECTRODE VALVE RECEIVING CIRCUITS. *The Wireless Press Ltd., has arranged with Marconi's Wireless Telegraph Co., to supply complete apparatus to the designs here given, as soon as Amateur restrictions are released.*

Article Seven—THREE-ELECTRODE VALVE RECEIVING CIRCUITS.

IN the last article we indicated broadly to the amateur the various types of circuit which are suitable for use in conjunction with a crystal detector. A crystal can only be used for one purpose, to rectify the oscillatory currents produced in the receiving circuits by the incoming signal in order that they may be rendered audible by the telephone receiver. In the case of a valve, however, there are four perfectly distinct ways in which the device may be applied in a practical receiving circuit, namely (a) as a high frequency magnifier; (b) as a rectifier; (c) as a note magnifier; (d) as a self-heterodyne for continuous wave reception.

(a) The Valve as a High Frequency Magnifier.

In this case the function of the valve is simply to increase the amplitude of the oscillatory currents induced in the receiving circuits in order that the rectifying device may operate to the best advantage. All rectifiers known at present, which are capable of working at radio frequencies, have a more or less rounded bend at the bottom of the characteristic curve. The presence of this bend renders the rectifier much less efficient for currents of small amplitudes than for those which cause the device to operate on the steep part of the curve. The result of this effect is to cause a signal to be inaudible, although there may be sufficient energy in the signal to be heard in the telephones. This point is treated at some length in "The Elementary Principles of Wireless Telegraphy," and we would particularly draw the amateur's attention to it.

In Fig. 1 we have indicated in the simplest possible manner the arrangement of a valve for magnifying high frequency currents. In this Figure

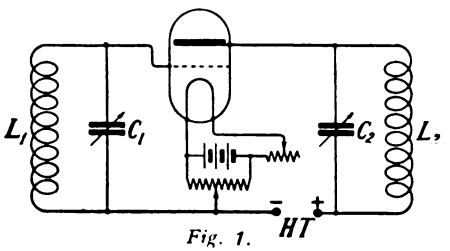

Fig. 1.

L_1C_1 is an oscillatory circuit made up of an inductance and variable condenser of suitable dimensions to tune to the desired wave length. The grid and filament of the valve are connected respectively to the terminals of the condenser C_1, the potentiometer being provided in

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order that the grid voltage may be adjusted so that the valve is working at the best point on its characteristic curve. A similar circuit L_2C_2 is connected in the plate-filament circuit of the valve, a source of high voltage E.M.F. being included in the position indicated. The circuit L_2C_2 has such values of inductance and capacity as to tune to the same wave length as L_1C_1. Any oscillatory current which may be induced from the receiving aerial or other source will cause high frequency alternations of potential across the condenser C_1, it is clear from the diagram that this fluctuation of P.D. is directly applied between the grid and filament of the three-electrode valve. The effect of these potential variations is to cause changes in the direct current flowing from the high voltage source in the plate-filament circuit of the valve. This fluctuating direct current, since it is varying at a frequency corresponding to the natural time period of the circuit L_1C_1 rapidly builds up a comparatively large oscillatory current in the circuit L_2 C_2. Thus it is clear that in the arrangement shown we have a weak oscillatory current flowing in the circuit L_1C_1 magnified by the valve and resulting a similar current but of greater amplitude in the circuit L_2C_2. This magnified current can readily be rectified in the usual manner, and thus made to affect the telephone receiver.

Fig. 2 illustrates a practical receiving circuit utilising the principle just mentioned. The circuit consists of an aerial tuned by means of a variable condenser and inductance if necessary to the wave length to be received. This aerial is coupled by means of the jigger primary to a grid circuit of suitable proportions. The inductance of the valve-plate circuit has connected across it a crystal, potentiometer and telephone transformer. The incoming signals will produce a current in the aerial which in its turn induces a current in the valve-grid circuit. The magnified oscillations in the plate circuit are rectified by the crystal and rendered audible by the telephones as described in the last article.

With regard to the design of the various circuits. The aerial and its tuning arrangements have been fully described in connection with crystal receivers, and the principles there laid down should be adhered to. Since the valve is a potential operated device the ratio of inductance to capacity in the grid circuit should be as large as possible. As far as the valve circuits are concerned there is no necessity for the plate circuit to have a large L/C value, but since the crystal rectifier is

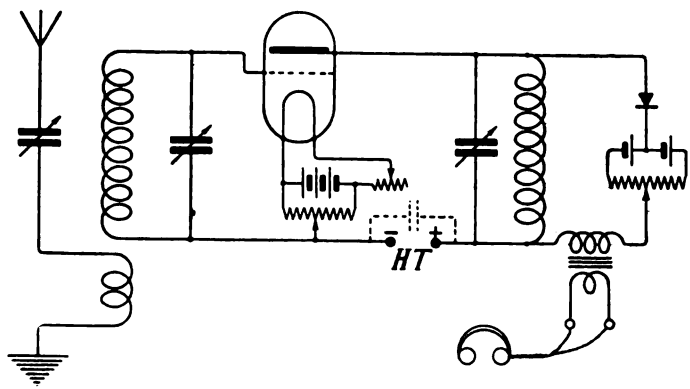

Fig. 2.

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connected across the plate inductance this circuit should also consist of a large inductance shunted by a small condenser. The amateur will do well to bear in mind the rule formulated in Article Six to the effect that the condenser of any oscillatory circuit used in connection with a potential operated device should not exceed ·0003 microfarads in capacity, the inductances being of such values as are required to tune to the received wave.

A study of Fig. 2 will at once reveal the desirability of employing a telephone transformer in preference to high resistance telephones in the crystal circuit. The secondary of the transformer is directly connected to the positive pole of the high voltage source and since the negative end is earthed either partially or completely through the filament batteries, the insulation between the windings of the transformer is necessary to protect the operator from unpleasant shocks. It should be noted that the apparatus comprising the circuit should be connected up exactly as shown in the figure; any other arrangement may lead to loss of efficiency. For example, if the telephone transformer were connected at the top end of the plate circuit instead of as shown its capacity to earth would result in a reduction of the potential applied to the rectifier with a corresponding decrease in the strength of signals. It is also desirable to connect a condenser directly across the terminals of the high voltage supply. This condenser is shown dotted in Fig. 2. Its function is to act as a reservoir condenser in order that the plate current may accurately follow the variations in resistance of the valve. It is particularly necessary when dry cells are employed for the high voltage battery; when the cells have been in use for some time the internal resistance rapidly increases and consequently the battery presents a considerable impedance to the high frequency currents. Also should a high voltage machine be used it will possess considerable inductance and may act as a complete break in the plate circuit to currents of radio frequency. In both these cases the condenser is obviously necessary, and the amateur should make a practice of including the condenser in his circuits as a matter of course.

(b) The Valve as a Rectifier.

In Fig. 3 is shown the arrangement of a circuit using a three-electrode valve as a rectifier or simple detector. The

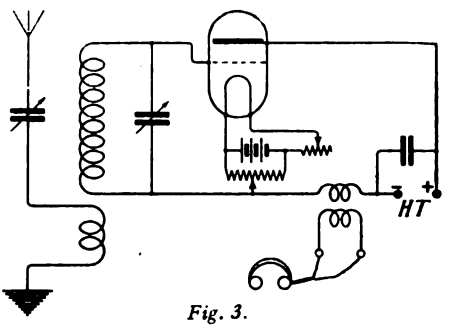

Fig. 3.

circuit is exactly the same in principle as that indicated in Fig. 4 of the last article. Again, the secondary circuit should have a large ratio of inductance to capacity, and the top end should be kept free in order that maximum potential may be applied to the grid of the valve. It should be borne in mind that when using the rectifying property of a three-electrode valve the potential of the grid is adjusted to such a value that we are working at the bend of the plate current characteristic curve. This bend is not very much sharper than that of a good carborundum crystal, consequently the sensitiveness of the arrangement is not materially greater.

(c) The Valve as a Note Magnifier.

The application of a valve to the amplification of the telephone current

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which is of note frequency is very similar in principle to the high frequency magnification described under (a) the difference lying in the fact that since we are dealing with currents of comparatively low frequency iron cored transformers of large inductance are employed instead of the tuned oscillatory circuits. A typical note magnifier circuit is shown in Fig. 4. The

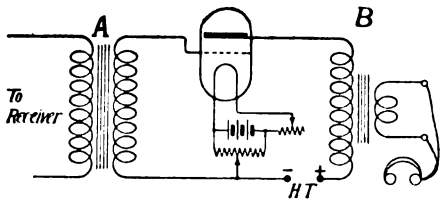

Fig. 4.

design of the grid transformer A will depend upon the exact conditions under which it is to be used. In any case the secondary (i.e., grid) winding will consist of a large number of turns of fine wire. The total number of turns it is possible to put on is limited by the fact that signals are muffled if this winding is made too long, as we cannot increase the inductance indefinitely without increasing the self capacity at the same time, and a point is eventually reached when the natural period of the windings is longer than that of the note to be amplified. The length of winding which may be used is found by experiment, and we shall give the amateur exact details when full designs are published. The primary winding should be adjusted to suit the manner in which it is connected to the receiver circuits. If directly in series with the crystal it should have about the same inductance as the high resistance winding of a telephone transformer; if connected in place of the low resistance telephone used in conjunction with the receiver it should have about the same inductance as the low resistance winding of a telephone transformer. The plate transformer may very well be an ordinary telephone transformer. Should the circuit show an inclination to sing the fault can generally be remedied by connecting one side of the telephone winding to some point on the valve filament battery. All contacts in a note magnifier circuit must be good. A partial break will at once show up as an intermittent crackling or sizzling noise in the telephones which may drown out even the strongest signals. If trouble is experienced in getting the magnifier quiet it should be placed on a soft felt pad in order to insulate it from mechanical vibrations.

The successful working of valve circuits is largely a matter of experience and only practice will enable the experimenter to diagnose and correct the many faults which are liable to occur in home-made apparatus. A thorough understanding of the principles of the action of the valve is essential, and the amateur should make certain that he has a complete grasp of its action before taking up the practical side.

In the next article we shall deal with reaction circuits and the self-heterodyne for continuous waves.

SPECIAL NOTE.

Owing to the continued delay by the Government in deciding the lines upon which the wireless amateur will be allowed to work, we have been unable to execute our original plans of supplying detailed information for the manufacture of amateur wireless apparatus. Pending an announcement of policy by the authorities our contributor will continue the present series along the lines already laid down.

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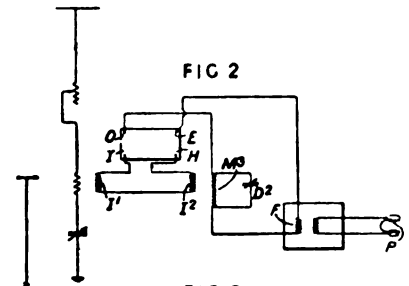
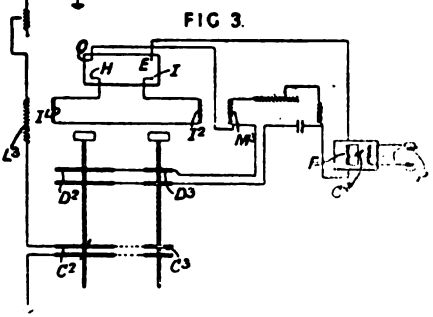
Patent Section

124,499. Wireless Telegraphy. Clarke, E. R., 35, Leinster Gardens, Hyde Park, London. February 11th, 1916. No. 2066 (Class 40 (v).)

A wireless receiving arrangement for heterodyne working with undamped waves comprises a tuned aerial circuit coupled in one coil of an intermediate circuit having another coil coupled to a tuned secondary circuit, the intermediate circuit being without a condenser and containing the grid and filament of a three-electrode valve, and the inductance and capacity of the secondary circuit are in parallel in the high-tension circuit of the valve. As

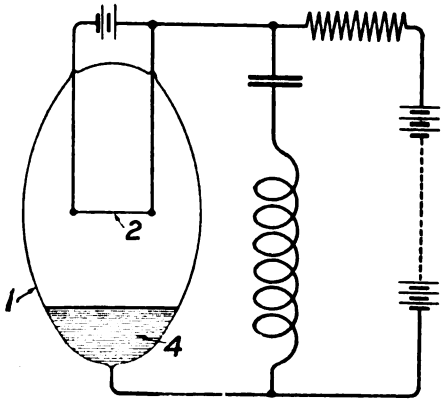




shown in Fig. 2, the aerial circuit is coupled to a coil I^1 in the intermediate circuit, which also includes a coupling-coil I^2, the valve grid connected to terminal I, and the filament connected through a potentiometer to the terminal H. A secondary oscillating circuit comprising an inductance M^3 and capacity D^3 is coupled to the intermediate circuit at the coil I^2, and is connected through a telephone transformer F to the terminals E, O of the valve. The terminal E is connected to the filament, and the terminal O is connected through a high-tension battery to the plate or outer electrode of the valve. The secondary of the transformer F is in circuit with a telephone P. Oscillations set up by the valve owing to its grid circuit and plate circuit being inductively coupled at the coils I^2, M^3 interfere with the received oscillations and give an audible note in the telephone P. The couplings L^3, I^1 and M^3, I^2 are preferably of the rotary type so as to give a loose coupling on either side of zero. In another arrangement shown in Fig. 3, fixed inductances and capacities are placed in the secondary circuit equal to those in the aerial circuit, and variable condensers C^2, D^2 are placed in the respective circuits and are adjusted jointly by rotating a common shaft so as to put the primary and secondary in tune with the incoming waves, as described in Specification 1402/15. Small variable condensers C^3, D^3 arranged one in each circuit, are subsequently adjusted by a common shaft but in such a way that as one is increased the other is diminished, so that both circuits are put slightly and equally out of tune with the incoming waves. The heterodyne note selected is that most suitable for the telephone employed, and the primary of the telephone transformer F is shunted by a variable condenser C^4 and tuned to this note. The telephone current in the coil F may be amplified by an auxiliary three-electrode valve, and a condenser placed between the terminal H and the corresponding terminal of the auxiliary valve.

126,030. Wireless Signalling. Soc. Francaise Radio-Electrique, 10, Rue Auber, Paris. October 31st, 1916. No. 15547. Convention date, December 8th, 1915. (Classes 39 (i) and 40 (v).)

Discharge-gap apparatus for the production of electric oscillations consists of an evacuated vessel 1, containing a heated cathode 2, and an anode 4 of mercury. Instead of mercury, an amalgam of a metal capable of emitting vapour may be employed. The amalgam may be distributed over the interior of the vessel; and the cathode may be convex instead of parallel to the surface of the mercury.



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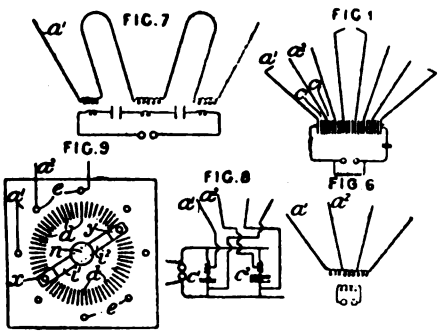
124,506. Wireless Signalling. Artom, A., 18, C. Siccardi, Turin, Italy. February 17th, 1916. No. 2402 (Class 40 (v).)

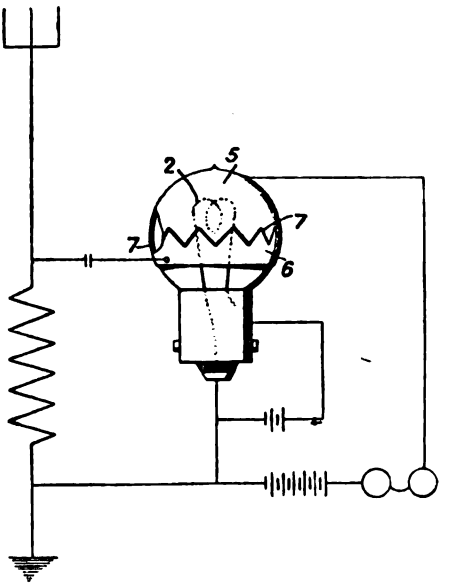
Directive propagation and reception is effected by connecting a number of co-planar aerials to condensers arranged in series or in parallel, or to intermediate points of an induction coil. Fig. 1 shows one arrangement with groups of condensers c^1, c^2, etc., in series in the generating-circuit and with the aerials a^1, a^2, etc., connected to the end plates of each group. The aerials may be placed symmetrically as shown, or unsymmetrically. In Fig. 8 the condensers c^1, c^2, etc., are shown in parallel in the generating-circuit, and the aerials a^1, a^2, etc., connected in pairs across the condensers. Loop aerials may be used instead of the open aerials shown. Figs. 6 and 7 show modifications in which inductance coils are substituted for the condenser battery. Fig. 9 shows a switch mechanism for varying the connections of the generating or reception circuit to the aerials. The condenser plates are arranged radially and are connected to contact bars d over which insulating switch arms i^1, i^2 may be adjusted separately by a knob n. Leads from the generating or reception circuit are connected to terminals x, y on the ends of the switch arms. The aerials a^1, a^2, etc., are coupled to terminals e which lead to intermediate points on the ring of condenser plates.



All the aerials may be tuned to one wavelength, or multiplex reception may be effected by tuning different aerials to the various wavelengths used. The currents in the various aerials may differ in strength and phase.

124,721. Vacuum Tubes. Connecticut Telephone and Electric Co., Meriden, Connecticut, U.S.A. (Assignees of Doule, H.P.; Meriden, Connecticut, U.S.A.) February 28th, 1919. No. 5047. Convention date, March 23rd, 1918. Not yet accepted. Abridged as open to inspection under Section 91 of the Act. (Class 39 (i).)

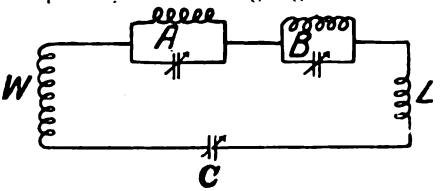
A valve for use in wireless telegraphy and telephony has a filament in an exhausted bulb and a grid and anode both mounted outside the bulb. As shown, the grid 6 and anode 5, which may both be of silver or copper, are mounted outside a bulb, for instance by electro-deposition, the anode being larger than the grid. The adjoining edges are separated by an insulating space 7, and may be serrated



as shown, or straight. It is stated that the bulb, when heated, permits an electron flow from the filament 2 to the anode and thus enables the valve to act as a detector or amplifier, and also as a generator of sustained oscillations.

126,146. Producing High-Frequency Oscillations. Marconi's Wireless Telegraph Co. and Shoenberg I., Marconi House, Strand, London. May 6th, 1918. No. 7596. (Classes 35 and 40 (v).)

With a view to utilising the qth harmonic of a high-frequency dynamo-electric generator, the ratio of the breadth of the rotor teeth to their pitch is made equal to the fraction $\frac{1}{q}$ multiplied by an odd integer greater than 1.



The induced winding W of the generator is connected through a capacity C and rejecting circuits A, B to an Inductance L, the circuit A being tuned to the frequency of the fundamental, and the circuit B to the frequency of the third harmonic, while the circuit W A B L C is tuned to the frequency of the utilised fifth harmonic. Specification 101,148 is referred to.

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Questions and Answers

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless telegraphy. Readers should comply with the following rules:* (1) *Questions should be numbered and written on one side of the paper only, and should not exceed four in number.* (2) *Queries should be clear and concise.* (3) *Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before.* **(4) The Editor cannot undertake to reply to queries by post.** (5) *All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or if so desired, under a "nom-de-plume."* **(6) Will readers please note that as amateurs they may not at present buy, construct or use apparatus for wireless telegraphy or telephony. (7) Readers desirous of knowing the conditions of service, etc., for wireless operators, will save time by writing direct to the various firms employing operators.**

R.S. (Howden).—The Association of Wireless Telegraphists, 69, Hastings House, Norfolk Street, Strand, W.C.2.

R.H. (Dursley).—We regret we are unable to comply with your request. There are, however, exceedingly few firms which do what you mention.

NONPAREIL (Cambridge).—(1) Yes, if you are fully qualified. See Note 7 at the head of this column. (2) Not connected with the Mercantile Marine. You might try to secure a position on a shore wireless station.

D.H.G.M. (Glasgow).—Asks: (1) Why some stations are heard better on No. 1 crystal of Marconi's Type 31 receiver, and others are heard better on No. 2 crystal?

This is probably due to the amplitude of the incoming oscillations of some stations suiting the characteristic curve of No. 1 crystal while the amplitude of other waves suits the characteristic curve of the other crystal.

(2) Why do some signals increase in strength when the coupling is loosened, while others decrease?

The coupling depends on the mutual inductance of the two circuits. In a well designed receiver it is possible to increase signals through the maximum strength and then decrease them. Hence although the position of the coupling coil is brought back towards *O* the coupling may be increased up to a certain point and then decreased.

L.A.W. (Bradford).—A formula for the calculation of the inductance of a "pancake" type A.T.I. is given in Fleming's Principles of Electric Wave Telegraphy, 2nd Edition, p. 139.

The inductance can, however, be approximately calculated as being equal to that of a cylindrical coil of the same number of turns, with a diameter equal to the mean diameter of the spiral, and axial length, equal to the width of the winding of the spiral, *i.e.*, $l = R_1 - R_2$ where R_1, R_2 are the radii of the inner and outer turns.

(2) We certainly do not advise you to make an inductance on the lines you suggest, as it would not be nearly as efficient as one wound on a single former owing to the capacity between each winding and the others, and the distribution of potential over the coils.

The resultant inductance of inductances connected in series is the sum of the individual inductances. In your case, however, the calculation is made more involved by reason of the mutual inductance between each coil and the remainder.

H.S. (Bexley Heath).—(1) A difficult question, for the length of time necessary for you to qualify for the P.M.G.'s Certificate depends largely upon what knowledge you have before you begin to study and upon how much time you can give to study. If you attend a good school you might succeed in six or nine months. (2) Practically so. You would have to pass the Doctor.

T.S.B. (Clapham).—(1) White uniform suits are essential but mess suits optional. (2) How can we possibly say whether "all naval tailors" can supply a certain kind of cloth? (3) No. For instance, many of the trawler installations are being dismantled. (4) You can take it as a certainty that wireless telephony will not *replace* wireless telegraphy in the Mercantile Marine, but is intended to augment the means of communication at present provided aboard ships.

F.B. (Hartfield Cove).—Please refer to Note 7 at the head of this section. If you have served as an operator in the Navy you should not have much difficulty in obtaining your P.M.G. Certificate, which is essential.

E.A.W. (Clapham Road).—(1) Sorry we cannot. Anyhow, there are very few of them, mostly colliers. (2) You might get your P.M.G. Certificate in six months, but you will understand that it depends not so much on the Course as upon your own capability. In any case it means very hard study and practice. (3) Better write to the Traffic Manager, Marconi International Marine Communication Co., Ltd., Marconi House, Strand, W.C., for a copy of Conditions of Service. You will find a full answer to your question therein.

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M.G.F. (Brighton).—All enquiries respecting facilities for wireless working should be addressed to the Secretary, G.P.O., London.

G.J.G. (New Cross).—You might apply to any of the Railway Companies who employ their own operators, but we do not think you will succeed in obtaining a shore position at once; the latter you might obtain by applying to Marconi's Wireless Telegraph Co., Marconi House, Strand, London, W.C.2.

V.H.A. (Tottenham Court Road).—Wireless Operators are trained in evening classes at the British School of Telegraphy, Clapham Road, and at the London Telegraph Training College, Earl's Court, London. Particulars of the fees can be obtained by direct enquiry. The length of training necessary depends largely upon the qualities of the student, but should not exceed nine months. The prospects of the profession can be ascertained by consideration of the conditions of service under the Company it is proposed to enter. Generally speaking, they are good.

T.H. (Birmingham).—To obtain a position as Wireless Operator in the Mercantile Marine it is essential to possess the Postmaster-General's Certificate of proficiency. On obtaining this, application should be made to the Marconi International Marine Communication Co., Ltd., Marconi House, Strand, London, W.C.2, which Company will give full particulars of the rates of pay, etc.

P.W.S. (Bletchley).—(1) No. (2) Yes, if supplemented by the training necessary to obtain the Postmaster-General's Certificate of proficiency. (3) In your case the necessary training would probably not exceed six months.

L.W.E. (East Sheen).—If you wish to become an apprentice in the Merchant Service write to the Assistant Secretary, Marine Dept., Board of Trade, Whitehall, S.W., for a list of Shipowners who take apprentices. We understand, however, that there are so many boys waiting to go to sea, that without influence you do not stand much chance of being accepted.

W.B. (Norfolk).—Asks: (1) Why the manipulating key is between the fuse and the transformer in the ½-K.W. Set, whereas in the 1½-K.W. Set the key is between the transformer and the L.F.I.C.

The transformer key and L.F.I.C. in both sets are in series and are connected across the terminals of the board, and it makes no difference if the relative positions of these in the circuit are altered.

(2) What is the exact action of the earth-arrester gap?

The use of this piece of apparatus obviates the necessity of using a change over switch for sending and receiving.

The earth-arrester gap is connected in series with the aerial, and the receiving instruments are connected across the gap. When the aerial is being used for transmission the high voltage in the aerial breaks down the resistance of the gap and a spark occurs. The resistance of the gap to the received oscillation is very great and as the received current cannot break down the resistance of the gap the current will flow round the receiving instruments to earth.

[With reference to the answer to the second question of "Query" (Gt. Yarmouth) in our last issue, part of this reply is unfortunately somewhat incorrect. The speed of the machine rises from its normal value whether the brushes are moved forwards or backwards from their normal running position. The test figures for a standard 1½-K.W. rotary converter are as follows:—

Brushes	Speed	A.C. Volts
Neutral	1500 r.p.m.	81
Moved forward	1570 r.p.m.	84
Moved backward	1530 r.p.m.	82

It will be noted that the rise of voltage in each case is practically proportional to the rise in speed, indicating that the increased A.C. voltage arises simply from the higher speed of rotation of the armature in the normal strength field, and that the effect of the demagnetising component due to the armature windings on the A.C. voltage is quite small. The reason why the r.m.s. A.C. voltage (which is what is read on the voltmeter) rises over the usual value of 0.707 × D.C. voltage, is to be found in the wave distortion that occurs when the brushes are moved, since the normal factor of 0.707 is true only for a sine curve. When the brushes are displaced the wave form becomes more rectangular in shape, with a consequent increase in the ratio of R.M.S. to peak value.—Ed., W.W.]

SHARE MARKET REPORT.

The market in the shares of the Marconi group has been very active during the past month. Large sales have been made on Italian account but all shares offered have been readily absorbed.

The shares of the American Company have appreciated considerably on the announcement from New York that all Wireless Companies will be amalgamated under one head in America and that considerable benefit will accrue to their Company in consequence.

Prices as we go to press (September 15th) are:—Marconi Ordinary, £5 12s. 6d.; Marconi Preference, £4 17s. 6d.; Marconi Marine, £3 3s. 9d.; American Marconi, £1 13s. 6d.; Canadian Marconi, 15s. 6d.; Spanish and General, 14s. od.

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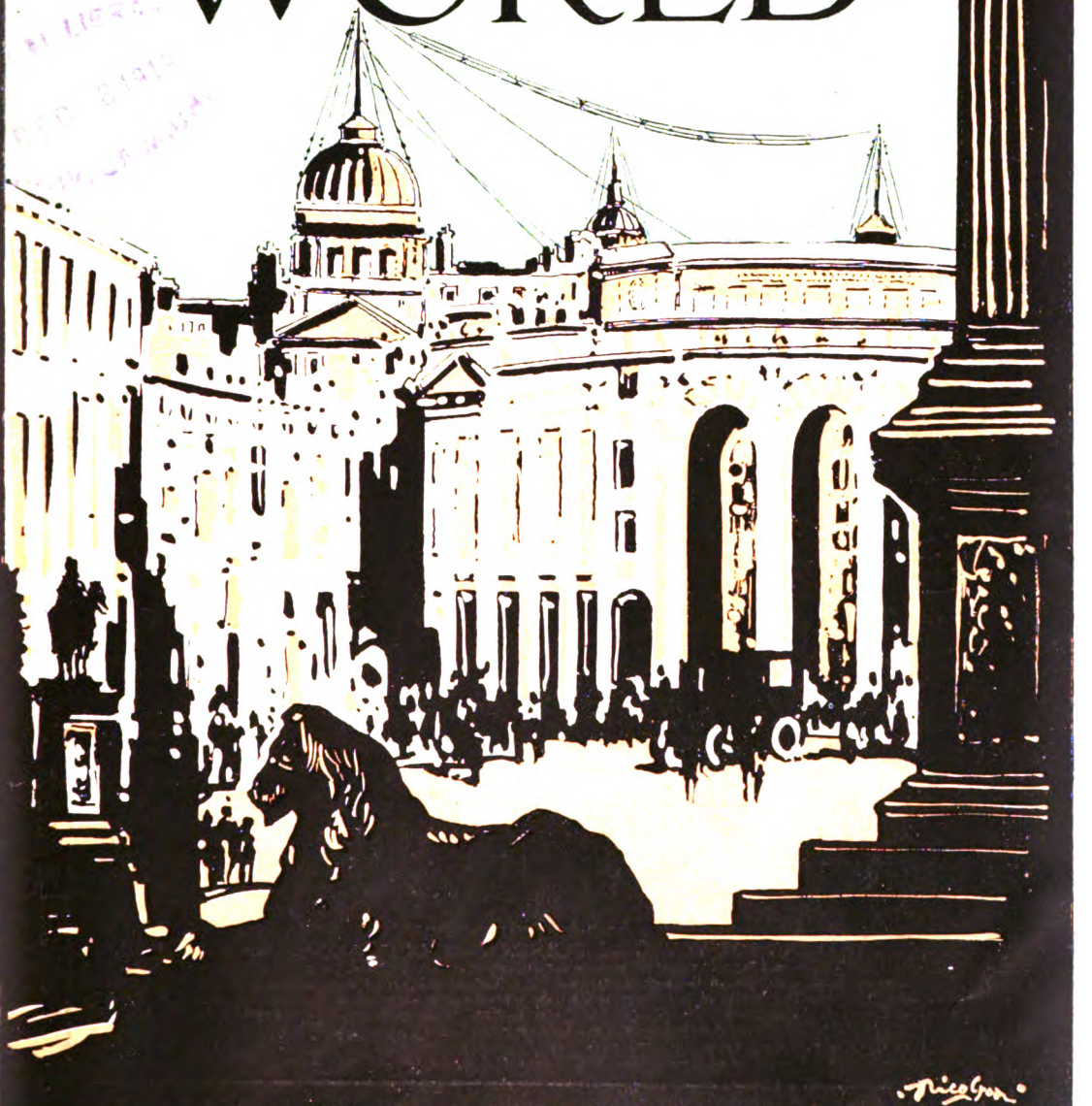
The WIRELESS WORLD



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THE
WIRELESS WORLD

No. 80
Vol. VII

NOVEMBER,
1919

Great Wireless Stations

TOWYN

IN our September issue we described the transmitting station at Carnarvon, thereby giving our readers some idea of what is really no more than half of the European establishment of that important transatlantic wireless service which might be called the Great Britain—America aether-line. To permit of duplex working another station, for reception and traffic handling, has been built at Towyn, some 60 miles south of Carnarvon. Although this station is only about 100 feet above sea-level it is surrounded by some of the finest Welsh hill scenery including the famous Cader Idris.

The main aerial runs from the station almost due east for a distance of 10,000 feet, ascending the steep Escuan hill, and is supported by five lattice-work masts and a smaller derrick at the leading-in end. Its height is about 1,500 feet above sea-level, from which position is commanded a fine view of the Dysynny Valley and Cardigan Bay. Parallel to this runs the reserve antenna, also 10,000 feet long, supported by 36 wooden masts each 35 feet high. Both aerials are directional for reception from the station at New Brunswick, and it is said that the lower one is of only slightly less value as regards strength of received signals than the main aerial, and that it is much more useful than the latter when "atmospherics" are troublesome.

At right angles to these aerials are the balancing aerials which are designed to eliminate interference from Carnarvon.

The receiving apparatus is elaborate, strictly up-to-date and designed with a view to maximum efficiency. The principal set comprises a high-frequency thermionic valve amplifier, with a balanced-crystal board for X-stopping.

The amplified and rectified signals are again amplified by a two stage L.F. valve amplifier. For "beat reception" a separate heterodyne circuit is provided. Automatically-transmitted signals are recorded on dictaphone cylinders which are transferred to special machines which can be regulated to enable the signals to be read by ear.

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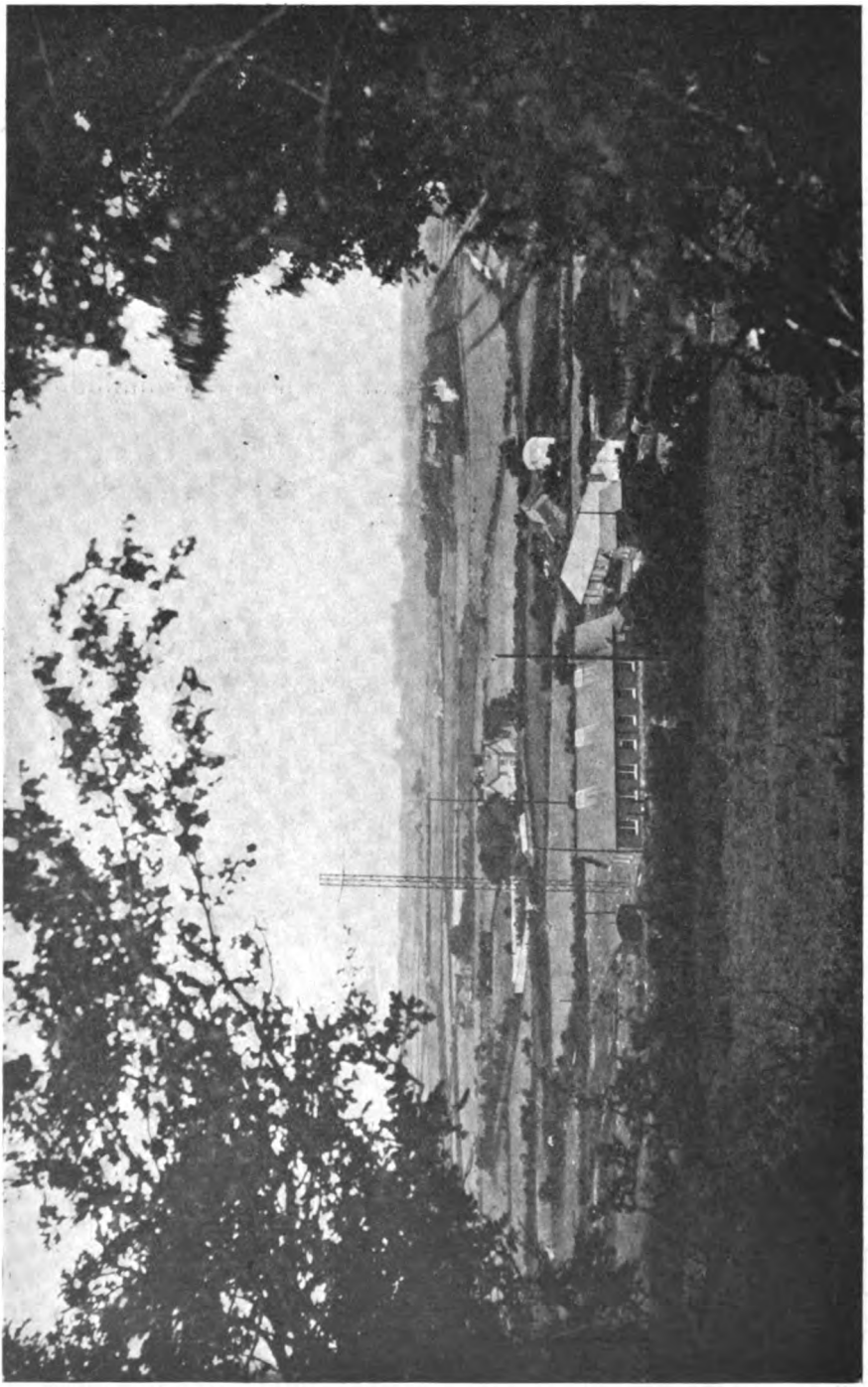

General View of Towyn Station.

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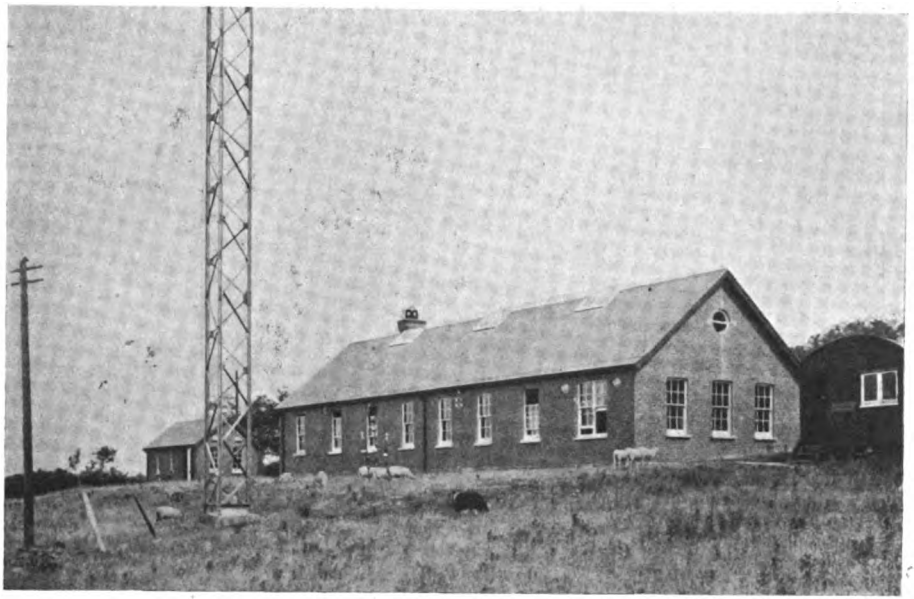
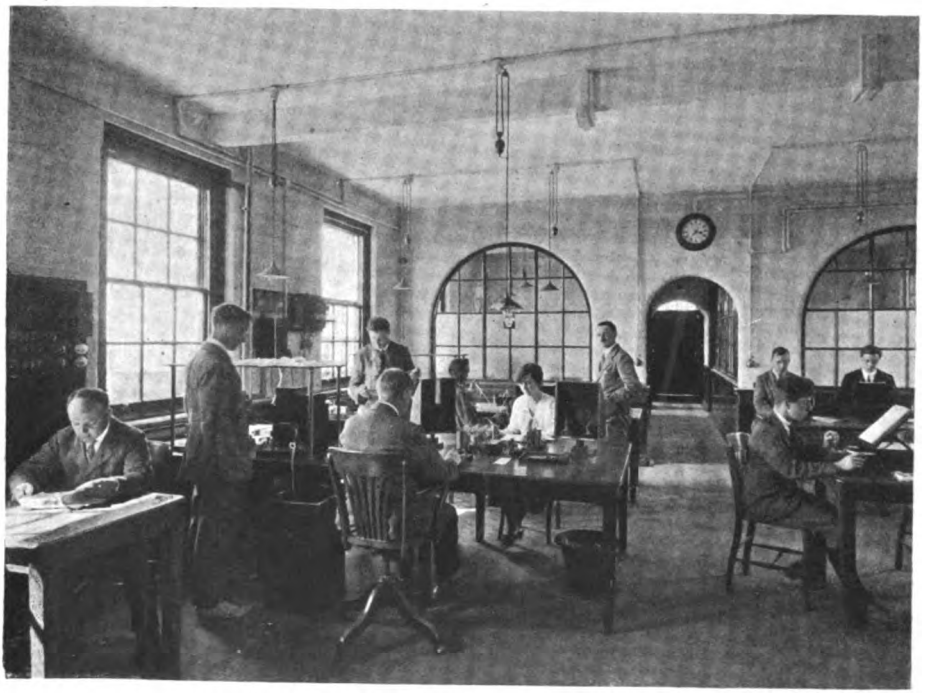


The Station Buildings.



The Transmitting Room.

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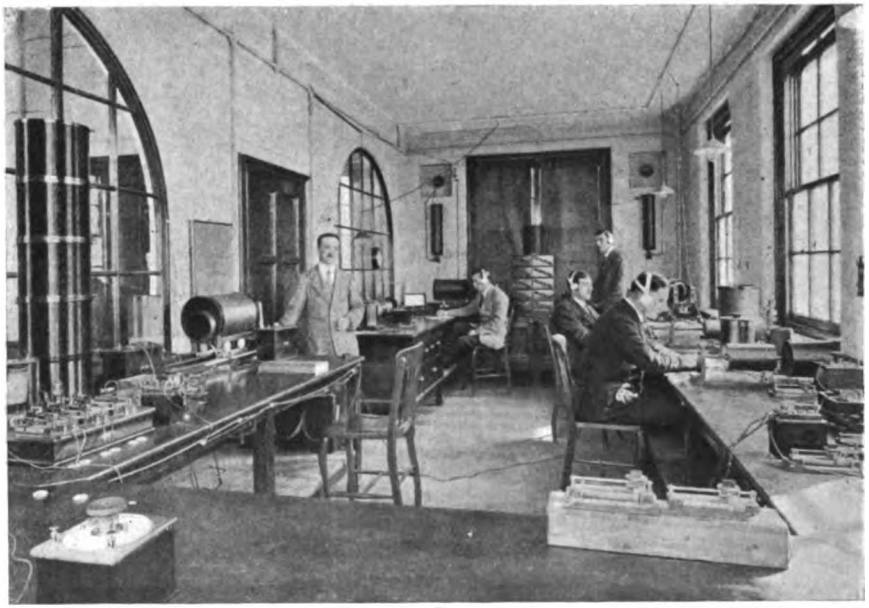

The Receiving Room.

The Dictaphone Room.

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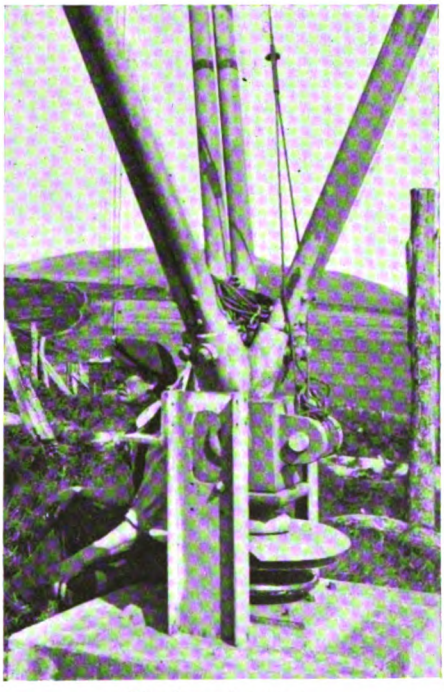
As regards transmission, although the power plant is situated at Carnarvon the actual operating is performed at Towyn. Let us imagine that a Bradford merchant wishes to communicate with his agent in New York, and follow the adventures of his message. It is handed in to the nearest postal telegraph office and sent to the Marconi Company's Fenchurch Street Office. At Fenchurch Street it is "punched" by a skilled operator, that is, it is transferred in the form of perforations to a paper tape, which is passed through an automatic transmitter which sends it along a special wire to Towyn. Here it is automatically reperforated and at once passed through an automatic wireless transmitter which is connected by landline to the signalling switches at Carnarvon. By this means Morse signals corresponding to the perforated paper tape are transmitted by the high-power Carnarvon plant at a speed of 100 words per minute. The receiving station on the American side is situated at Belmar, near New York, and here the message is received and forwarded by a short special landline to the public offices of the American Marconi Company in New York City for despatch to the addressee.



The base of a mast.

Messages received at Towyn from America are read from the dictaphone records, as previously mentioned, and transferred by "punching" to paper tape which is passed through an automatic machine over the landline to Fenchurch Street, where it is reproduced. It is then attended to by a Creed Printer, an automatic typewriter which translates the Morse Code into Roman characters on another paper slip. The latter then passes through the gummer and is affixed by the operator to the ordinary message form. Finally, the completed message is "unpacked;" this process consists of decoding the address, writing the full name and address of the addressee, plus any special instructions given and sending the whole to a delivery department where it is despatched by a messenger, or sent to the Central Telegraph Office for transmission to and delivery in the Provinces.

What has been described, taken in conjunction with our article about Carnarvon forms a picture of a model modern transocean duplex wireless telegraph system, and the British public may well ask why the entire Empire is not already linked by wireless, seeing that such an excellent demonstration of commercial long-distance working has been afforded as the result of private enterprise here in our own country.

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WILLIAM NOBLE, ESQ.

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Personalities in the Wireless World

MR. WILLIAM NOBLE, who has been appointed to succeed Sir William Slingo as Engineer-in-Chief at the General Post Office, entered the service of the Post Office in 1877, serving as a telegraphist in the Aberdeen Office during the earlier part of his career. In 1893 he received his appointment as a second-class engineer, being promoted four years later to first-class engineer in the Engineer-in-Chief's Office.

In 1900 Mr. Noble was made a technical officer and rapidly rose to be an Assistant Superintending Engineer in the Central Metropolitan District, in which position he bore his full share of the " heat and burden of the day," which was specially arduous on account of the telephone competition which arose. By his energetic handling of the manifold problems and difficulties which always specially beset the path of a second in command, Mr. Noble thoroughly earned his promotion in 1905 to first-class staff engineer. In accordance with the wise policy which forbids that the senior officials should plough a single furrow, Mr. Noble was then called upon to direct the Telegraph Section at headquarters. In 1907 he was appointed Superintending Engineer of the Central Metropolitan District, in which capacity he at once devoted himself to improvements in organisation, and in this, the supreme test of an administrator, he was eminently successful. As a result he was soon appointed a member of the Superintending Engineers' Committee, the prelude to a long series of appointments on committees for his work on which he received special recognition in the form of an allowance of £100 per annum.

March, 1912, marked Mr. Noble's ascent to the position of Assistant Engineer-in-Chief, and it is easy to judge how arduous and exacting his duties must have been since then, considering that nearly five years of war have intervened, bringing with them their inevitably heavy demands upon a great government department. Nevertheless, Mr. Noble's recent appointment as Engineer-in-Chief is warranty that his head and shoulders proved equal to their respective tasks, and that in making it the responsible authorities have but acted upon a perfectly logical conclusion.

Amongst his other multifarious responsibilities Mr. Noble will have much to do with regard to wireless telegraphy. The sound engineer's judgment, the conscientious and unfaltering pursuit of efficiency—the engineer's true hall-mark—and the recognition of the far-reaching effects of his decisions, which Mr. Noble surely brings to his new post will, we trust, help in no small measure to place and maintain the Empire's official wireless services on a fittingly high plane.

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Notes on the Design and Construction of Vacuum Tube Amplifiers

By J. Scott-Taggart, M.S.Belge E., A.M.I.Radio E.

I.—LOW FREQUENCY AMPLIFIERS.

THE valve amplifier in modern wireless telegraphy has become an indispensable piece of apparatus. At first only experimental circuits were used. Now, however, circuits capable of giving very great amplification are embodied in a compact instrument and made commercially. No station is complete without such an amplifier and no experimentalist will fail to possess an instrument which will enable him to receive over distances perhaps ten times his normal range.

Such amplifiers may conveniently be divided into the two classes, high and low-frequency amplifiers. The first class is suitable for use in any detector circuit where normally ordinary telephones would be used. They do not rectify but simply magnify rectified pulses of current. They are also useful for amplifying telephonic speech if the latter is faint. In a word, they will magnify current variations of low-frequency.

The second class, the high-frequency amplifiers are usualy complete detector-amplifiers. They may be connected across any circuit in which an oscillatory current is flowing and will produce loud signals in the amplifier telephones.

The high-frequency amplifier varies somewhat in design, but it often consists of a rectifying valve followed by one or two low-frequency amplifying valves. It is proposed in the following pages to discuss from an essentially practical point of view the design and construction of several types of successful amplifiers. Their construction presents no great difficulty in spite of the mystery in which they were shrouded during the war.

Since a high-frequency amplifier often consists partly of a low-frequency amplifier, the latter type will first be considered.

There are one or two points of difference between the "diagram" type of amplifier circuit and the actual practical instrument. The former generally consists of one or two valves with separate lighting accumulators and separate high-tension batteries. It serves to illustrate a principle; it is forgiveable in a fixed station, but as a practical circuit it is unnecessarily cumbersome and extravagant. One requires something easily portable; something that can be rapidly connected to different circuits. Our first thought, then, is to develop amplifiers using *one* lighting accumulator for all the valves and *one* plate battery.

The coupling between the valves, whereby the magnified voltage variations are transferred from the plate circuit of one valve to the grid circuit of the next, is another matter for consideration. There are three well-known methods of effecting this coupling, namely:—

(1) The use of inter-valve transformers,

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*(2) The use of auto-transformers between the valves,

*(3) The use of high-resistance couplings.

Of these three methods, the first appears to be the most satisfactory for low-frequency amplification, and it is proposed to deal, in the present article, with that type.

In Fig. 1 we see a very simple one-valve amplifier which could be connected to any circuit where normally an ordinary pair of telephone receivers

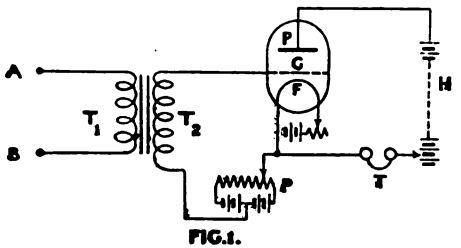

FIG. 1.

A single-valve Amplified Circuit.

would be connected; for example, we could connect A and B to the telephone terminals of an ordinary crystal detector receiving circuit. T_1 is the primary winding of a small step-up transformer, the secondary T_2 of which is connected, through a potentiometer P, across the grid G and filament F of a vacuum tube. The plate circuit of the valve consists of the plate P, a battery H of about 80 volts (loosely termed a high-tension battery), a pair of high resistance telephones T, and so to the filament F of the valve.

As this simple amplifier will be the basis for more elaborate instruments we will look at it in further detail. The step-up transformer claims our attention first. The primary winding T_1 should have the same resistance approximately as the circuit to which it is applied. In the case of a crystal detector circuit this resistance is high, and we should therefore wind the transformer with fine insulated copper wire to a resistance of from 300 ohms to 2,000 ohms or even more. The secondary winding T_2 may conveniently have about ten times as many turns as the primary. The voltage across the secondary winding of the transformer will therefore be about ten times that across the primary. The value of having this initial transformer will therefore be readily seen, since the greater the variation of grid potential, the greater will be the current variation in the plate circuit of the valve.

The transformers used in most amplifiers are of the closed-core type. Fig. 2 shows a simple form which can be constructed without much difficulty. It is built up of an ebonite tube about $\frac{1}{2}''$ external diameter and $2''$ long. At each end is fixed a square ebonite cheek $2''$ x $2''$ through which a $\frac{1}{2}''$ hole has been drilled. Wooden cheeks and a paper tube soaked in paraffin wax, could be used if desired. On this tube is wound the primary winding. This can best be

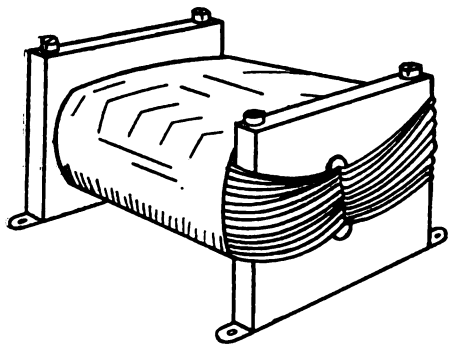

Fig. 2.

The completed Amplifier Transformer.

accomplished by rotating the tube on the shaft of a small electric motor. The two ends of the winding should then be brought to two small terminals fixed on one of the cheeks. The secondary winding may be wound in

*Vide the Author's "The Use of Impedance, Capacity and Resistance couplings in High-frequency Amplifiers." WIRELESS WORLD, Feb., 1919.

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the same direction in a similar manner, the two ends being brought out to terminals fixed on the other cheek. The greatest care should be taken to insulate the windings which should be separated by one or two layers of " Empire " varnished cloth. It is also preferable to wind the coils in sections to prevent the insulation breaking down.

The iron core is the next consideration. This may conveniently consist of a bundle of soft iron wires. As there should be no residual magnetism in the core during the operation of the transformer, the wires should preferably be made of " Stalloy," a special commercial product eminently suitable for this purpose. The wires should preferably be lacquered to prevent the setting up of eddy currents.

The bundle of wires forming the core should be about 7" long, and, when fitted into the ebonite tube, should project about $2\frac{1}{2}$" beyond the cheeks. This done, the wires at each end should be parted into two, each half being bent round the side of the cheek. This is shown in Fig. 3 which is a plan of the transformer. The ends A and B, and C and D, are now worked into each other so that the core appears as two rectangular rings. The body of the transformer is now wound round with varnished cloth and securely bound. Its finished appearance will be as shown in Fig. 2.

Suitable windings for an initial transformer for general work are :—

Primary : S.W.G. 44 S.S.C. copper wire, 300 ω.

Secondary : S.W.G. 44 S.S.C. copper wire, 3,000 ω.

The resistance of this size of wire is about 1 ohm per foot, so that 300 feet would be required for the primary and 3,000 feet for the secondary.

The potentiometer P can usually be dispensed with, although when distortion of the current variations is to be avoided (as in wireless telephony) some arrangement for varying the grid potential is highly desirable. The reason for this has been fully explained by the author elsewhere.*

The arrangement in Fig. 1 consists of the usual potentiometer, which

* Vide " On Valve Characteristic Curves and their Application in Radiotelegraphy." WIRELESS WORLD, September and October, 1918.

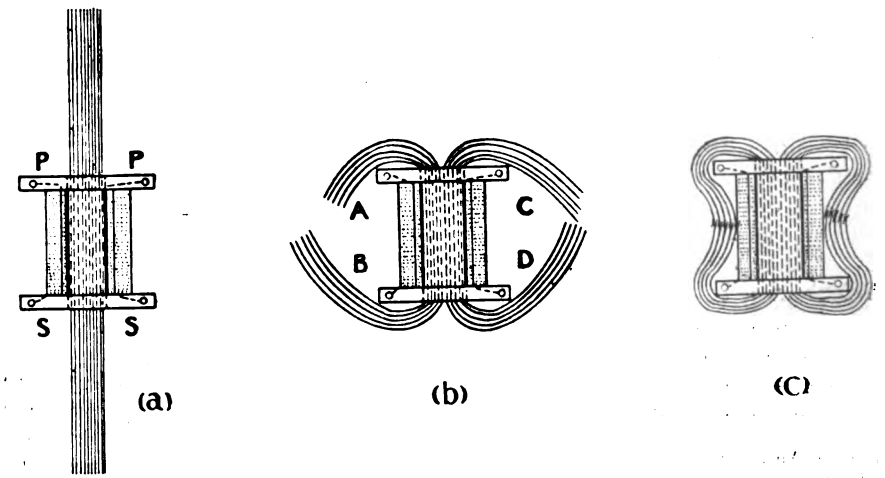

Fig. 3.
The stages in the construction of an Amplifier Transformer.

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enables either a positive or negative voltage to be imparted to the grid. There are two important disadvantages of this arrangement:

(1) The potentiometer battery is continually "running down,"

(2) The potentiometer battery requires to be twice the maximum voltage it is intended to give the grid.

The first disadvantage is accentuated on some instruments where a potentiometer switch is provided. The operator frequently omits to switch off his potentiometer battery when leaving the instruments. This could be remedied by arranging that the potentiometer switch is opened when the filament current of the valve is turned off.

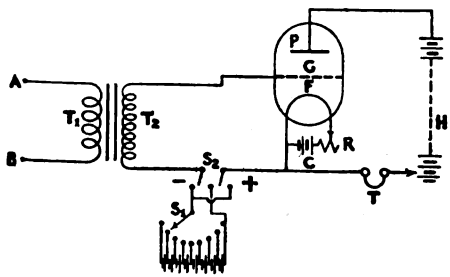

Fig. 4.

A Single-Valve Amplifier.

The author prefers the arrangement shown in Fig. 4 and which has been used by the Marconi Co. Instead of a potentiometer we now have about 10 small dry cells and a radial switch S_1 of ten studs which enables us to tap off the voltage we desire to give the grid. The three cells found in an ordinary flash-lamp battery are of a suitable type for use in this connection. The voltage is variable in steps of about 1.3 volts, and the range is sufficiently large to enable us to use any part of the grid potential-plate current characteristic curve of the average small valve. The normal adjustment to use is the half-way point along the steep straight portion of the curve, although for undirectional pulses any point may be chosen provided the representative point does not move off the steep straight portion of the curve during the pulse.

A small commutator switch S_2 may be provided if desired. This, together with the radial switch, enables the operator to vary the grid potential from −13 volts to + 13 volts. When amplifying speech or currents of an alternating nature, it is advisable to increase the voltage of the battery H until the curve of the valve lies completely to the left of the grid zero ordinate. A suitable negative voltage of the grid is then chosen to bring the representative point to the middle part of this curve. This can be accomplished with a sufficient degree of accuracy by means of the grid voltage radial switch. No rectification will now result through the establishment of grid currents.

Instead of connecting a pair of high-resistance 'phones directly in the plate circuit, it is preferable to use a step-down telephone transformer T_3 as shown in Fig. 5. Its high-resistance winding is included in the plate circuit, and may conveniently be wound with S.W.G. No. 44 single silk covered wire to a resistance of about 5,000 ohms. The low-resistance winding may be wound with the same wire to a resistance equal to that of the 'phones to be used—perhaps 120 ohms. The author will, in various diagrams, sometimes omit to show the telephone transformer for the sake of clearness.

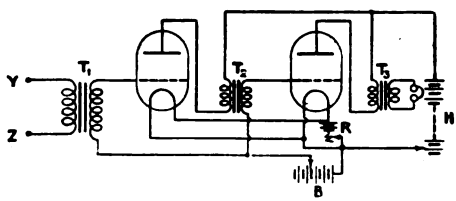

Fig. 5.

A 2-Valve L.F. Amplifier.

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We now come to the 2-valve amplifier, shown in Fig. 5 which employs an additional valve and a coupling transformer T_2. This transformer is of the same type as the first one described. It serves to step-up the voltage changes taking place in the plate circuit of the first valve and passes them on to the second valve. The voltage changes across the grid and filament of the second valve are made about 5 times as great as those across the windings included in the plate circuit of the first valve. The transformer ratio is, in other words, one to five. The primary winding may be wound to 300 ohms and the secondary to 1,500 ohms, using the same wire as before. These values give excellent results, but there is no reason why they should be too closely followed. Different commercial types of amplifiers vary very much indeed in the resistances of their transformer windings.

It will be noticed that the filaments of both valves are connected in parallel. The filament current rheostat R, which consists of a resistance wire of about 5 ohms and a sliding contact, affects both valves, and is adjusted to the value which gives the loudest signals.

The plate battery H is variable in steps of 15 volts by means of plugs, and serves the plate circuits of both valves.

The voltage of the grid cells B is communicated to the grids of both valves by suitable wiring, as shown in the figure. This is desirable since both valves will function best under almost exactly the same conditions.

The telephone transformer is connected in the plate circuit of the second valve.

A 3-valve low-frequency amplifier is shown in Fig. 6. As will be readily seen, it is a similar circuit to that of Fig. 5 except that an additional valve is provided, the telephones being included in the plate circuit of the last valve.

It will be found advisable on these types of amplifiers to connect all the iron transformer cores together by a wire which is also joined to the positive pole of the high-tension battery.

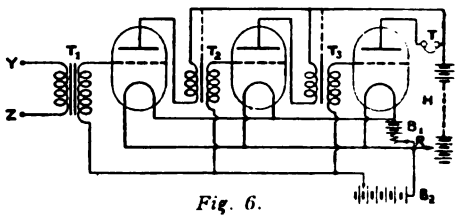

Fig. 6.

A 3-Valve Low-Frequency Amplifier.

This wiring is shown by dotted lines in Fig. 6. This helps to eliminate the sizzling noises frequently heard during the operation of these amplifiers.

(*To be continued.*)

OUR COMPETITION FOR WIRELESS OPERATORS.

In our September number we announced the opening of a competition solely open to ship and shore wireless operators, our aim being to stimulate their interest in the problems of their profession and to provide data from observations taken all over the globe (as a result of their work in the competition) for the use of scientists. Competitors are intended to read the special article which was written for their guidance by Dr. W. H. Eccles, and published in our September and October numbers, and then to proceed to work at that particular problem for which they feel best fitted, both as regards personal taste and opportunity. Full particulars of the rules of the competition are given in the September issue. The prizes offered are:

First prize, twelve guineas; second prize, six guineas; four consolation prizes, each consisting of Dr. Fleming's new book, entitled *The Thermionic Valve and Its Developments in Radiotelegraphy and Telephony*, and Mr. Philip R. Coursey's *Telephony without Wires*.

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Digest of Wireless Literature

By E. V. Appleton, M.A., B.Sc.

SHORT-WAVE RECEPTION AND TRANSMISSION ON GROUND WIRES (SUBTERRANEAN AND SUBMARINE).

By Lieutenant-Commander A. Hoyt Tayler.

Proceedings of the Institute of Radio-Engineers, August, 1919.

THE experiments of Clark, Rogers, and Lyons, carried out in America, have shown that practically all the Arc stations in the country can be received easily with subterranean and submarine antennæ. The signals are, of course, much weaker than those received on an ordinary antenna, but there is one advantage in that, whereas strays very often prevent reception with ordinary aerials they produce comparatively much smaller effects in the case of ground antennæ.

The results of Rogers are the most satisfactory in that his experiments were made with valve detectors which have brought about the many practical possibilities in subterranean reception. In his experiments Rogers had an underground room into which leads were run from various wires buried underground at approximately a depth of one foot and which ran out in various directions. These wires varied in length from 300 to 1,000 feet. Some were bare wires, some were insulated, and some were laid in baked clay for part of their distance. The receiver consisted of ordinary coupled circuits with valve reception. Tests on short waves in the neighbourhood of 600 metres were made to determine whether the apparatus was directive and also to determine which kinds of wires gave the best results. The wires were usually tried in pairs in a straight line, one wire being connected to the antenna terminal of the receiver and the other to the earth terminal. Directivity was quite evident, the best results being obtained with signals coming parallel to the wire pair. The bare wires were found to give the greatest strength of signals. It appeared that the proper length of bare wire for optimum signals at 600 metres lay between 300 and 500 feet (92 and 153 metres). The strays were found to be more completely eliminated when the set was tuned for short waves than when tuned for long waves.

The present communication consists of the results of further experiments on these lines. In these experiments which were carried out at Great Lakes it was found that several receiving sets could be connected simultaneously to the same pair of ground wires without interference. In continuous wave reception the heterodyne notes of course are present, but when the wave-lengths are not too close together interference can readily be avoided.

The primary circuit formed by the wires, the primary inductance, and a series condenser were tested by means of a wavemeter, and it was found that with wires over 100 feet in length the lengths of the buried wires had practically no influence on the tuning of the primary. This would seem to indicate that the ground wires themselves formed an aperiodic system. Further more detailed experiments (described later) however, showed that this conclusion was not strictly true.

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The work was carried out in close proximity to the Great Lakes station which possesses two overhead antennæ for transmission. It was possible to receive Arlington spark signals on 2,500 metres on a north and south pair of ground wires at the same time as one of the ordinary antennæ of Great Lakes was radiated on 600 metres, and to read Milwaukee on 600 metres (a station 50 miles distant) when the Great Lakes arc was in operation on 6,000 metres radiating 50 amperes. As far as handling regular traffic was concerned the subterranean antenna station was able to do much better work than the station with overhead antennæ owing to the elimination of strays and to the ability to work through storms during which the overhead antennæ had to be earthed. The best signals were always obtained with well insulated wires laid in wet sand. Iron pipe earth connections were tried at the ends of both antennæ, but no difference in signal strength was noticed. The strays, however, were slightly worse. The use of multiple wires appeared to offer no material advantage.

Some further experiments of a more quantitative nature were carried out to determine the lengths of wire necessary for optimum signal strength for any wave length. Switches were installed at various points along a pair of north and south wires 300 feet long and audibility measurements were taken of various stations. The optimum wire length was always found to be approximately one-eighth of the wave length. The experiments showed that there was in most cases quite an abrupt rise in signal strength when the optimum wire length was secured. This was marked for short wave lengths, but for longer waves the signal strength was independent of the length of the wire. The optimum lengtn was found not to depend on the direction from which the signal came.

In these experiments strays as a rule were practically absent. Sometimes loud cracks widely separated were received. These isolated strays, although loud, did not interfere with the reception of signals on account of their brief duration. When the optimum wire length is used it is very important that the wires should be properly insulated since earthing a wire produced a diminution in signal strength. Here it was again evident that for the best results the wires should be laid in fairly wet soil or in water in which case (a) the signal strength is a maximum, (b) the relative suppression of strays is most marked, and (c) the set is most selective when the optimum length is used. If the wires are laid in salt water they must not be fixed too deep as the signal strength falls off with increase of depth. Curiously enough in fresh water, for long waves at least, no diminution in signal intensity is noticed even when the wires are laid as deep as 60 feet below the surface.

If one wire and an earth are used instead of a pair of wires in a straight line the signal strength is reduced about 35 per cent., but the optimum wire length is still the same. Such a wire and earth system is highly directive so that the best listening-in arrangement for picking up signals is obtained by connecting a pair of wires situated at right angles both to one terminal of the receiver, the other terminal being well earthed.

The theoretical explanation of this system of reception is not wholly understood, but the following points seem noteworthy. Since ground wire reception may be carried out with wires very near the surface of the ground (although not as efficiently as when the wires are buried deeper), the phenomenon must depend upon the well known inclination of the advancing wave front, thus giving a

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horizontal component of the electric force in the æther parallel to the ground wires. It is also likely that this angle of inclination increases with the penetration of the wave, especially when that penetration reaches wet soil of considerable conductivity. It is possible, of course, that buried wires may also act in a way like loops, the capacity of the antennæ to the ground supplying (by means of the conducting ground) the complete circuit.

Signal reception on ground wires follows the same law of diurnal variation and seasonal variation as reception on an ordinary antenna.

Only preliminary experiments on transmission with subterranean antennæ have as yet been carried out, but they have already shown that continuous wave telegraphy with low power sets may be carried on over considerable distances. The greatest communicating distance obtained was between Great Lakes and Chicago, a distance of 36 miles. In this particular case the antenna current was 0·8 of an ampere.

AMPLIFIERS FOR CONTINUOUS AND VERY LOW FREQUENCY CURRENTS.

By MM. Henri Abraham and Eugene Bloch.

Comptes Rendus, 168, June 30th, 1919.

THREE-electrode valve amplification has been utilized to a large extent in the case of alternating currents of higher frequencies, such as those utilized in wireless telegraphy and telephone circuits. It is, however, important in certain applications to be able to amplify in a similar manner alternating current of extremely low frequency (of 1 to 100 alternations per second) or even continuous currents. This problem arises if it is proposed to record wireless signals mechanically. The mechanical recorder (recording galvanometer, Morse apparatus, etc.), requires working currents of the order of one milliampere. If a current of this value is to be reached without a mechanical relay the valve amplification must be pushed to a maximum. A feasible scheme appears to be to amplify the musical audio-frequency telephone current first and after that use an extreme low frequency amplifier, the rhythm of the Morse signals being regarded as an alternating current of very low frequency.

Two types of amplifiers have accordingly been devised:—a continuous current amplifier and an extremely low frequency amplifier.

1. If we place in the anode circuit of a valve a resistance comparable with the internal anode circuit resistance (about 50,000 ohms) a variation of grid potential produces a variation of current in the anode circuit and consequently a variation of potential across the resistance. This variation of potential can be transmitted directly to the grid of a second valve, care being taken to insert a battery in the wire connecting the high resistance and the grid in order that the grid potential may be maintained at the most favourable value.

By repeating this insertion of batteries between successive valves of a resistance coupled amplifier a circuit is found capable of functioning at all frequencies and in particular for extremely low frequencies and for continuous current.

As the connecting battery between two valves can only be varied by discontinuous steps (by two volts at a time if accumulators are used) a small variable

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resistance is inserted with each anode circuit resistance. The necessity of introducing extra batteries, besides the heating and anode batteries, does not make this scheme convenient for high-frequency or audio-frequency amplification. But the employment of these extra batteries is necessary in continuous work.

2. The connections between successive valves of a resistance-coupled amplifier can be carried out by means of large capacities of the order of 0·1 or 0·2 microfarads. Each condenser is then in a high resistance circuit of several meghoms and thus possesses a time constant which may be as large as several seconds. As a result the apparatus amplifies current with a period less than its own time constant. Experience shows that it is a good plan to shunt the anode circuit resistance with capacities of the order of 0·25 microfarads in order to avoid reactions between the extremely low-frequency amplifier and the ordinary audio-frequency amplifier which precedes it in the stages of amplification. In all cases the linking condensers are made as small as the rhythm of the signal currents will allow. For example, for the reception of wireless signals sent by hand $\frac{1}{2}$ microfarad is used; in the case of automatically sent signals of 40 or 50 words a minute $\frac{1}{10}$ microfarad is sufficient.

Besides applying this apparatus to the mechanical recording of wireless signals, it has also been used for the measurement of extremely feeble currents met with in experiments on gaseous ionization.

THE APPLICATION OF AMPLIFIERS TO THE RECORDING OF WIRELESS SIGNALS.

By MM. HENRI ABRAHAM and EUGENE BLOCH.

Comptes Rendus, 169, August 11th, 1919.

The experiments on the mechanical recording of wireless signals were carried out during the years 1916 to 1918 for the Radiotelegraphic Section of the French Army. The receiving system used consists of a framework of 1·2 metres diameter carrying 40 turns of wire 14 mm. apart. This coil is connected to a variable condenser and the two constitute the primary receiving circuit. For the recording of powerful stations relatively near (less than 2,000 kilometres distant) the strays or atmospherics were relatively so feeble that a secondary circuit could be dispensed with, and the amplifier was connected directly to the primary circuit. In the case of extremely weak signals from very distant stations it is found that it is necessary to use a secondary circuit loosely coupled with the primary. In the case of continuous waves accurate tuning is essential. In such cases auxiliary valves have been used which have the effect of introducing a negative resistance in the primary receiving circuit. It is possible to eliminate in this way the greater part of the effects due to atmospherics.

The amplifiers used on these receiving circuits are of two kinds :—

(1) The French military R6 type. This is an eight valve amplifier, comprising five stages of high-frequency amplification, one stage of rectification, and two stages of audio-frequency amplification with transformer coupling.

(2) An amplifier for continuous currents, or for currents of extremely low frequency, usually with three stages of amplification.

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The recording apparatus is inserted directly in the anode circuit of the last valve in the position normally occupied by the telephone in an aural receiving set. If continuous waves are being received with the aid of a heterodyne it is advisable to place the latter inside a metallic screen through a hole in which are brought two leads to a coil which is coupled with the main circuit. By altering this coupling it is possible to alter the effect of the of the heterodyne until the most sensitive setting is obtained.

The recording apparatus may be either a Morse inker or a galvanometer with pen attachment. In both cases it is advisable to use coils of fine wire of several thousand ohms, making the resistance of the apparatus comparable with the internal resistance of the valve. For the Morse apparatus a current of two milliamperes is necessary. A sensitiveness of twelve times this amount can be obtained with a special magnetic oscillograph which makes records on prepared paper. The natural period of this latter instrument ($\frac{1}{100}$ of a second) is so small that it readily accommodates itself to the frequencies of automatic transmission.

The recording apparatus, whatever it is, functions from a zero effect to a saturation effect, that is to say the amplification is made so enormous that the anode current which actuates the recording apparatus has its maximum value during a signal and falls to zero during the interval between two signals. This mode of action, obtained without a mechanical relay possesses important advantages. It eliminates completely some of the effects of strays or atmospherics. During a signal the anode current of the last valve reaches, if the voltage is sufficient, its saturation value above which it cannot, of course, be increased. This current is therefore not altered by any strays, however strong the latter may be. During the intervals between the signals the grid of the last valve becomes strongly negative and a stray of moderate intensity will not have sufficient effect to cause this potential to mount to zero. It is thus clear that there is a double limitation to the action of strays because of the existence of what may be termed a "threshold of action" in the valve, and because of the existence of a saturation value for the anode current. Moreover, in the case of two sets of signals simultaneously heard in the telephone, but sufficiently unequal in intensity, the record of the stronger only is obtained on the Morse apparatus.

By employing the arrangement previously described it has been found possible to receive with the small coil or antenna, and to record correctly by Morse instruments, all the large European and American stations. In the case of European stations, the distances of which do not usually exceed 2,000 kilometres (Lyon, Nauen, Berlin, Clifden, Coltano, Aranjuez, Moscow, Constantinople, etc.), no particular precautions are necessary. In the case of American stations (New Brunswick, Annapolis, etc.) which are about 6,000 kilmeotres distant, special precautions are necessary to obtain optimum tuning. These stations, however, can be recorded quite correctly even while the powerful Eiffel Tower station is sending. It has been found possible to work these sets for several hours at a time.

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Our Amsterdam Letter

Arrangements have been made with a prominent Dutch radio worker to publish each month a letter dealing with the practice and progress of wireless communication in Holland and her colonies. It is hoped to carry out the same idea in respect to other countries, thus providing professional wireless men with a regular, condensed account of the work and thought of overseas technicians, and a means of keeping British amateurs in touch with the doings of their confrères abroad.

I HAVE been recently honoured by a request from THE WIRELESS WORLD to keep the readers of that magazine informed of all the events in our little Dutch wireless world which might be of interest.

If a similar request had reached me prior to 1914 I should have been obliged to refuse, simply because there was next to nothing worth mentioning, except that the Belgian Marconi Company had again given the advantage of wireless to so many ships; that our army had no proper working field station, or that it had come to my knowledge that the Government had ordered a Marconi telephone condenser, and that the electrolytic detectors in use at the Scheveningenhaven station were homemade. Perhaps it would have interested you to know that plenty of our responsible authorities were careful enough to receive with reserve the significant reports from abroad about long-distance working and its possibilities, and that in consequence they gave the problem of a wireless communication with our colonies hardly a serious thought. No, there was not much to be recorded at that time.

But all that is quite altered now! Since the war turned the whole world topsy-turvy it is all wireless bliss in little Holland. Even the old people no longer charge the ether waves with causing the bad summer season. They only shake their heads thoughtfully when they listen to the wireless speeches coming from Marconi's Wireless Telephone Station at the E.L.T.A. (First Aircraft Exhibition at Amsterdam.)

When as a consequence of the war Holland became practically isolated from the rest of the world, wireless telegraphy became the pet of every Dutchman, and judging from appearances it throve well under the fervent attention it has received since that period.

Every one wanted his own receiving set in order to get the latest news. Many a broker and banker bought a coil and detector and sat listening for days, hoping to intercept stock quotations from America.

As there were no instruments coming from abroad, many people became constructors of wireless receiving apparatus which were promptly sold for good money, while the "odds-and-ends" shopkeepers became prosperous as never before, because they got rid of all sorts of wire, serviceable or not, for the manufacture of receivers.

Here is a story which speaks for itself. One day a gentleman dropped in with the request that I would look at his receiver, with which he had no success whatever, he said. At his office he

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showed me an instrument of poor workmanship which seemed to have been built for demonstration purposes. When I made inquiries as to the whereabouts of his aerial wires, he scrambled on the top of a cupboard and produced two brass discs of 4 inches diameter, fixed at the end of two rods each a foot long. When he was asked what he expected to receive with it, he said: "Well . . . eh . . . some war news and . . . well, yes, America, if possible." Asked about his ability in receiving, he said: "Oh, yes, dots and dashes. That would be all right; such a Morse alphabet could be easily obtained . . !" And this man paid over £8 for his receiver, and dreamt of reading American stock quotations!

That with so much interest in the radio art life would be given to an amateur club is easily understood. This joyful event took place in 1916, and at present we number nearly 1,100 members and a monthly magazine. This is certainly not bad for little Holland. In every town of importance in Holland a section of this club is formed, having their own clubrooms, where weekly meetings, with instructional courses, interesting demonstrations and lectures are occasionally given. The home-made radiotelephone set which I have seen at the wireless den of one of our members is remarkably good, and shows that the Dutch amateur is certainly no longer at the rear.

I hear that there is a movement amongst the members to obtain the Government's permission to use transmitting sets on a small scale and on similar lines to those of our American friends.

But I have my doubts whether this desire, at the mere thought of which our amateurs' hearts are throbbing, will be granted soon, unless our Society is able to convince the authorities of the utility of such a freedom for non-official dabblers. I hope it will not be too difficult a job for our administration! Official Holland has sometimes such queer habits where novelties are concerned.

Do you know why Holland is said to be always behind other countries in some respects?

For instance, there is not one Dutch pilot-boat equipped with wireless apparatus yet, and our shipping companies are not yet compelled by law to carry wireless on their ships above a certain tonnage, while in nearly every seafaring country it is compulsory. It is not a consequence of conservatism or lack of diligence on the part of our governors, but only because they are so extremely averse to being called imitators. This may also be the reason why in Holland advantage is seldom taken of experiments for the perfecting of instruments which are made abroad. They prefer to stick to expensive trials, coming finally to the same results, than to be more practical and build further on the knowledge offered to them from abroad.

A few days ago the agreement between the S.A.I.T. and Radio Holland was finally signed. The latter will henceforth instal and control the wireless installations on board ships in Holland and in the Dutch East Indies. Thus our good old S.A.I.T. sun disappears out of sight, but surely not out of the hearts of all those who have been in her service. Radio Holland certainly starts business on far better conditions than her predecessor; a good number of ship stations, a well-trained staff of operators, and, above all, the ever-growing belief that wireless is an indispensability on sea-going ships.

The new Company belongs to the Marconi Associated Companies, and participates in the privileges to which the ship stations of the Marconi Wireless organization are entitled.

BUZZER.

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"W/T. R.E."

An Account of the Work and Development of Field Wireless Sets with the Armies in France.

By Capt. B. F. J. Schonland, O.B.E., R.E., late Staff Officer (Wireless) 1st Army, France.

(Continued from October Number.)

I HAVE already briefly described the power buzzer, the "loop" set and the B.F. set. The first was an ingenious adaption of the early experiments in "wireless" conduction through the earth, the last-named a compact 50-watt spark set using an induction-coil with magnetic make-and-break. The loop set, specially designed for forward trench work or open fighting, presents many points of interest. Transmission is carried out on a "closed" circuit, the inductance from which energy is radiated being a square frame-work of brass tubing about a metre inside.

For effective radiation the wavelength used must be small, power being limited by the weight of the accumulator carried. The set is made for wavelengths of 65 or 80 metres, the brass loop fitting on to a small ebonite box containing spark-gap and condenser, which in turn clips on to a bayonet stuck into the ground, while a rubber lead enables the operator to manipulate his key and have induction-coil and accumulator under shelter some twenty feet away. The receiving apparatus comprises a two-valve circuit of a most ingenious type and ground aerials only seven yards long. Though the power of the set is only twenty watts, it is capable of signalling over from two to five miles, while the forward transmitting loop can be completely screened from enemy observation by being placed in a trench or dug-out, without much weakening of signal strength.

A technical description of the types of continuous wave sets used is beyond the scope of this article. The circuits employed have in some cases already been described in THE WIRELESS WORLD by other writers.

One or two valves were used for transmission, high tension for the plate circuit being supplied either by small primary cells, special types of induction coil (tonic train), or small rotary converters with or without rectifying devices.

While the sets for forward use were small and designed for simplicity and portability, other more complicated sets were fitted up in cars and lorries for special work behind the lines.

Masts and aerials varied in type and height according to the set used, and its proximity to the enemy. The usual spark trench set mast was fifteen feet high and made up of small tubular steel sections, while the aerial varied in length from 50 to 100 yards. Usually when shelling was particularly bad a number of aerials were erected, led in at different points to the dug-out used as station, so that if one was cut another could be employed. In the case of C.W. sets a very short and low aerial was possible, sometimes measuring no more than ten yards long and four feet high, and supported on tripod masts or any convenient ruin to hand. The directional property of the L type aerial was found to be very strong, even with short-range sets, and of course especially so in the case of low or ground aerials.

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As a rule the aerial was led into the dug-out which housed the set, by means of thick rubber-insulated cable, though the damp walls of the shafts and stairways often gave trouble, especially with continuous wave sets. For earth connection a copper gauze mat was used, buried or simply laid out on the ground if the station had to be very mobile.

It is easily seen that messages sent by wireless, unless extremely urgent, could not be sent in "clear." The Germans, like ourselves, had special arrangements for intercepting wireless messages and special facilities for letting the fighting troops take advantage of anything learnt from our messages. So that, unless delay was dangerous, our messages were enciphered before being sent. So adept did our operators become that unless the message was a long one, the loss of time in this way was small. For messages which could not wait, the endorsement "To be sent by wireless in Clear" was all that was required. Cipher messages were always sent twice to ensure correct reception.

The daily routine of the operator in trench warfare when no fighting was going on was mainly concerned with the fetching and carrying of rations and accumulators, and the disposal of a few practice messages each day, as well as keeping a continuous watch by day and by night, in case of sudden attack. Of his work when a battle started, the moving and carrying forward of his station, erecting masts and aerials, "getting through," sending and receiving messages all in the dust and din of the fighting with shells breaking his aerial every few minutes—of this an epic could be written, but he himself would merely glance at the medal he wore, and say nothing.

The necessity for keeping strict control and continuous watch over our sets in the line was due to the fact that the Germans possessed a very complete system of intercepting stations, with a staff of expert deciphers. The latter were ready to pounce on any message where the operator had made a blunder, hence the reason for strict control of our traffic. German army headquarters kept a tame mathematical Herr Professor for deciphering our messages, according to captured German wireless operators. The Herr Professor apparently hardly earned his pay to judge by the secrecy maintained in our heavy traffic during battles.

On our own side we were well organised for obtaining important information from the distribution of enemy wireless sets as well as for decoding their messages. For the former we employed special position-finding (P.F.) stations. The usual name "D.F." would be more accurate, for in each of our five armies we had a number of such stations all connected by telegraph and telephone to a central headquarters where the bearings made by our stations on enemy sets were plotted, and the positions of the latter found within a few hundred yards.

The *interception* of enemy messages was also an important part of the work of these "Wireless Observation Groups" as they were called. For although the Boche used a difficult code for his messages, a code changed every few weeks, we too had our decoders, and very able ones. The weekly acrostic in the *Sunday Times* was a good preparation for wrestling with German messages and many of our code experts were recruited from the ranks of the acrostic-solvers! Sometimes, too, the methodical German made a slip and by sending a message first in code and then in "clear" or something similar, made us a present of his efforts in encoding any further messages.

Yet another portion of an Army

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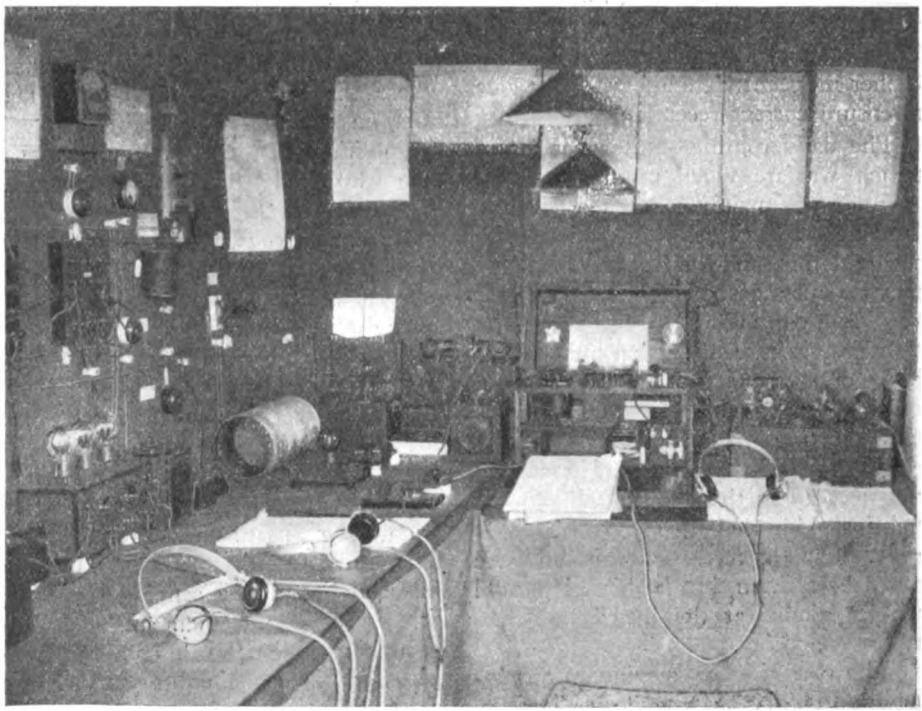
Wireless Observation Group was devoted to the rapid location of any enemy aeroplanes observing for their artillery. From the moment the poor Boche tried his wireless over the aerodrome he was kept under wireless observation and before he had properly begun registering the "shoot" a special R.A.F. squadron had been telephoned to and a 'plane was on its way to interrupt the proceedings. Great success was obtained by these aeroplane P.F.'s., and while numerous "shoots" were stopped, sometimes a dozen enemy 'planes would be shot down in a week owing to the information as to position given in this way.

Of the instruments and apparatus used in our later P.F.'s. it will suffice to say that with the advent of the hard valve it was found possible to effect many changes and improvements on the original Bellini-Tosi aerial system and the circuits used. The big amplification obtainable nowadays made it an easy matter to reduce the size of the triangular aerials, and in fact to make the direction-finding depend not on the balancing of a radiogoniometer but on the actual rotation of a triangular loop aerial. All this made for simplicity and lightness, important factors in military work.

The development of these cunning wireless intelligence devices made both sides become more and more cautious as time went on. Camouflage and counter-camouflage in 1918 made things very interesting. Wireless sets were concentrated in areas where no attack was contemplated, and sets in areas where attacks were preparing, were kept normal. Many were the devices employed to cover up weaker points in our



An Army H.Q. Telegraph Station.

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line by using extra sets at dummy headquarters and by moving existing sets from one spot to another. Every weak point in our system was watched, and utilised to delude the trusting Hun on P.F. or intercepting set.

Of German spies with wireless sets spotted by our P.F.'s., of others with receiving sets found in other ways, of weary journeys in motors in search of wireless spies—which sometimes ended in the discovery of a misguided British wireless operator in the back-areas (after one had crept dramatically up, revolver in hand)—much could be written. But I cannot close this narrative without a reference to the "I.T.'s." or listening sets, which though not strictly "wireless" sets were yet so important a part of the wireless sections work.

The "I.T.", so called apparently because it was a "hush-hush" apparatus simply consisted of a special three-valve amplifier placed in a dug-out close to the front line and used to pick up enemy telephone, buzzer and power-buzzer messages by means of earth-pins inserted in the ground at points as near as possible to the German trenches. These pins were placed in No Man's Land at night and cable leads led back from them to the dug-out containing the amplifier. The Germans, like ourselves, used telephones freely at one time in their front-line system, and owing to leakage from the telephone cables, either actual or by induction, it was possible to hear German officers talking sometimes louder than they could hear themselves. In this most important department of intelligence the Germans were first in the field, hence their almost uncanny knowledge of such things as infantry reliefs. Our first listening sets were in use in the spring of 1916 and grew in number as their value was realised. They were manned by German-speaking operators attached to wireless sections and their installation and up-keep devolved upon corps wireless sections. The information gained by them was most important, comprising conversations giving away the strength of the units holding the trenches, times and dates of reliefs, projected raids, mine-explosions and attacks, as well as the names of divisions, brigades and battalions in the line. I can only give one example from a host of cases where the "I.T.'s." information saved the lives of numbers of our men or caused German plans to fail. On September 7th, 1917, the interception of German messages by one of our listening sets enabled warning of a hostile raid to be given some time before it was launched. The attack at 5.30 a.m. was completely repulsed. The following were the points noticed which led us to take successful counter-measures:—

(1) Unusual amount of conversation over the telephone from 8 p.m. onwards.

(2) A speaker appeared to be very anxious that everyone should be on the alert. This was reported to our battalion H.Q. at 10.20 p.m.

(3) Time signals for synchronisation of watches were interchanged at 4.41 a.m.

Here is another case—December 5th, 1916. "Hullo, who is there?"———

"Berlinerhaus here, what do you want?"———

"What, a mine to-night?"———

"Well, good health."

The conversation was faint, but our listening set warned Brigade H.Q., and the mine went up late that night.

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The Thermionic Valve as an Oscillator

AN IMPORTANT LEGAL DECISION.

In the judgment given below it is declared that Claim 1 of Dr. J. A. Fleming's United States patent No. 803,684, for the thermionic oscillation valve, covers its use not only as a radio-detector but as an oscillation generator. This decision is of special interest because it upholds the view that a patent covers not only the use of an invention in the manner described by the patentee, but also the use of the invention in a reverse manner, even if the possibility of the reversed use is discovered after the date of the patent.

UNITED STATES DISTRICT COURT.

Southern District of New York.

MARCONI WIRELESS TELEGRAPH COMPANY OF AMERICA, *Plaintiff*,

AGAINST

DE FOREST RADIO TELEPHONE AND TELEGRAPH COMPANY, *Defendant*.

J. Edgar Bull and L. F. H. Betts, of New York City, for plaintiff.

Samuel E. Darby and Samuel E. Darby, Jun., both of New York City, for defendant.

Final hearing on supplemental bill. Mayer, District Judge:—

The Fleming patent No. 803,684, so far as concerned a detector for radio waves, was fully discussed in *Marconi v. DeForest*, 236 Fed. Rep 942; affirmed 243 Fed. Rep. 560.

The effect of the decision *supra* of this court, as affirmed by the Circuit Court of Appeals, *supra*, was to accord Fleming's invention a high place in the art.

Eight or nine years after the date of the Fleming patent—the exact dates are unimportant—Armstrong, Hogan, Waterman, Weagant, and probably other experts in the radio art, while using these devices as radio wave detectors, independently observed that the detectors possessed the function of oscillating or, in other words, of generating radio waves. This was an extraordinary additional property or function of the so-called incandescent lamp detector of which Fleming had no knowledge.

Claim 1 of the patent in suit reads:

"1. The combination of a vacuous vessel, two conductors adjacent to but not touching each other in the vessel, means for heating one of the conductors, and a circuit outside the vessel connecting the two conductors."

While the claim covers broadly the device when used in the radio art, yet when read with the context of the specification, it is plain that Fleming's disclosure was addressed to use of the instrumentality as a detector only.

It is, however, a principle of the patent law—so well settled as not to call for citations of authority—that a patentee is entitled to all the benefits of his invention whether or not known to or foreseen by him.

Thus, the first inquiry is whether the Fleming valve, as disclosed by the patent, will oscillate when used in circuits and with instrumentalities available as of the Fleming date and of the kind and character which, upon the evidence, it would be assumed would or could have been used as of that date.

The testimony of the experts and numerous demonstrations in the court

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room (some required by the court by way of extra caution and assurance), proved beyond peradventure that the two element valve possesses inherently the same capacity for generating radio waves as is possessed by defendant's three element device.

The only question in this connection is whether plaintiff, in order to hold this feature of the Fleming invention, may use a battery.

Obviously, the Fleming valve cannot oscillate unless a battery is used; but, to use a battery would, of course, not involve invention, once it is determined that the Fleming valve possessed inherently the ability to generate radio waves.

As counsel for plaintiff aptly say, "one might as well ask whether a boiler could be made to generate steam without a fire under it or whether a dynamo could be made to generate electricity without an engine to drive it."

Indeed, on this branch of the case, the question is whether, in order to make the Fleming valve oscillate, anything need be done or added which would amount to invention. As the answer to this enquiry is plainly in the negative, one necessarily returns to the proposition that as Fleming gave the art a new instrumentality and as that instrumentality without inventive changes or additions will oscillate as well as detect, he is entitled to this feature although unknown to him.

The next question is: If the two element valve will certainly and reliably oscillate in common and well known detector circuits of Fleming's day (Marconi or P.N. circuit), but will not certainly and reliably oscillate in the precise circuit shown in the Fleming patent without a condenser, is Fleming entitled to the benefits of the device as a generator of oscillations?

The valve was made to oscillate without a condenser although the action in this regard is not certain and reliable; but this latter is immaterial.

The main case has really disposed of this point because this court and the Circuit Court of Appeals have held, *inter alia*, that Fleming's contribution was the device *per se*, which could be used in any circuits and with any instrumentalities then known to the art.

Bell Telephone Case, 126 U.S.1.

Indeed, the case on analysis is much simpler than when first presented.

On preliminary impression there is reluctance to extend the patent to an unexpected characteristic only observed after a considerable lapse of time by the highly skilled men who are students in the art. Yet, after all, it was Fleming who made this remarkable contribution of a wholly new device which, of itself, and in its development has done so much toward the practical advance of this great art.

The case is fully as meritorious as *Western Electric Company v. La Rue*, 139 U.S. 601, 605, which, as nearly as may be, presented an analogous question.

Under the authority of that case it is clear that where there is a capacity of reversibility with the same instrumentality, the courts will not restrict the claim to one attribute to the exclusion of the reversible attribute; and, for that matter, this case is stronger than the La Rue case because Claim 1 *supra* is broadly for the instrumentality.

It is concluded, therefore, that the so-called oscillion of defendant infringes and that the decree heretofore filed should be extended thereto with costs.

Submit decree accordingly not later than July 11, 1919.

July 7, 1919.

District Judge.

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Stray Waves

THE AMATEUR POSITION.

SOMEWHAT to our surprise and greatly to our regret the British radio amateur still remains suspended in space, nearly a year after the signing of the Armistice with Germany. He is, to put the matter in a thermionic nutshell, in an uncomfortable position between the filament and the grid. He cannot obtain a licence, and even with the "special permission" which is obtainable he may not transmit. Even when he succeeds in convincing the authorities that he is a fit and proper person to be allowed to receive wireless signals, his aerial is cut down to a minimum which will certainly not satisfy the needs of an ambitious worker. We cannot but regard the whole affair as an attempt to keep amateurs out of the radio field, and, even bearing in mind the points which the Post Office must safeguard, we think that far too strong a line has been taken. Under the existing conditions it looks as though the raw beginner stands no chance whatever. There certainly is a ray of hope for him coming from the direction of the Wireless Society of London, but we advise the amateur community in general to combine forces, to interest Members of Parliament in their case and to urge, by every means at their disposal, that the whole question be fairly thrashed out. If officialdom is allowed to wield the bigger trumpet the amateur will find himself so restricted that he will have to seek another hobby, and that, it would seem, is precisely what is desired of him, and precisely what must not happen. We do not know whether the Wireless Society's officials see eye to eye with us on the question, but we hope that in their dealings with St. Martin's le Grand, they will not remain silent on its broader issues which concern not only the skilled research workers but a growing army of intelligent, scientific-minded boys and youths, deeply interested in aether-wave phenomena, who desire to amuse themselves with wireless apparatus—a desire which should be fostered as carefully as any other bent which keeps the hands and minds of the rising generation engaged with scientific work and reasoning.

* * *

SUPER-RADIO.

A note in *Electrical Industries* refers to a letter recently received from Mr. F. L. Ranson in connection with his latest book. It appears that Mr. Ranson is leaving England for a six months' lecture tour through the United States and Canada, where, he says, "they are far more advanced in matters of this sort than we are here." Apparently the "matters" referred to are the following:—"From the natural science point of view, thought is a high-tension current right above the Marconi wave, and every sin and every disease has its own cell in the sub-concious mind. If the cells are clean, nothing can cause them to vibrate. For instance, if the anger cell is clean, no angry thought can possibly make that man angry, and even a million people could not hypnotise him into being angry. If the cell is not clean, that is, has small electrical particles on it, they damp it down as pitch does a tuning fork, and the cell will vibrate and the man be angry. Good thoughts are high vibrations and bad thoughts are low vibrations."

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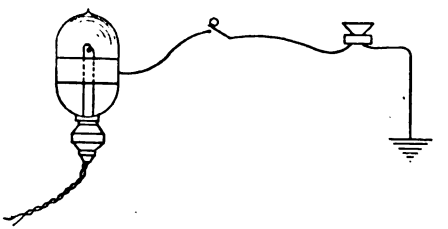
We should like to know what is the frequency of some of the thoughts expressed in the foregoing quotation!

* * *

THE "EDISON EFFECT."

From *La Nature* we take the following simple method of demonstrating the well-known "Edison effect." A strip of tin-foil is fastened around the outside of an ordinary metallic-filament electric-lamp and from this strip a connection is taken to earth *via* a telegraphic key and a telephone (see Fig.). When the lamp is lit by direct current the circuit is repeatedly made and broken by means of the key, and at each "make" a sound is heard in the telephone.



The interesting point about this experiment is that the emitted electrons are able to pass through the glass in increasing quantities as the temperature of the glass rises. On being plotted as a curve, micro-amperes against degrees of temperature, it is found that beween 100° C and 200° C, the conductive value of the glass rises to a sharp peak.

* * *

WIRELESS TELEGRAPHY BY INVISIBLE INFRA-RED RADIATION.

Messrs. J. H. Stevens and A. Larigaldie have recently communicated to the Paris Academy of Sciences particulars of a device by means of which they have obtained records of infra-red radiations over distances of more than 20 kilometres, the best results being obtained with a thermocouple. They used as a source of emission an arc or electric lamp projector, the luminous flux of which was absorbed by a filter screen, a black glass coated with manganese dioxide or gelatine. Such screens absorb 50% of the total energy but do not allow any rays which may affect the eye to pass. The perceiver is a parabolic mirror arranged to trap the maximum radiant energy, the thermopile being placed at the focus of the mirror. It is interesting to note that in September 1919, signals were exchanged between two stations 14 kilometres apart, the transmitting station in this case being provided with an arc projector of 1.5 m. Also in May, 1919, experiments were carried out between two stations 7,500 m. apart, the transmitting station using a 4 m. mirror and an 800 watt nitrogen filled electric lamp and the receiving station a gilt mirror of 0.24 m.

* * *

WIRELESS TELEPHONE EQUIPMENT OF THE N.C.4.

Interesting details of the radio-telephone apparatus carried on the N.C.4 are given in the *Aerial Age Weekly* for June 9th, 1919. The set has succeeded in transmitting speech from an aeroplane in flight over a distance of 150 miles using a 600 ft. trailing antenna radiating a maximum aerial current of 2.5 amperes. The N.C. boats are also fitted with fixed emergency aerials which are stretched whilst the craft is taxi-ing or floating on the water. These sets permit of three different types of transmission (1) speech currents, (2) C.W. (3) Audio-frequency damped waves. Two wavelengths are in use, 16,000 metres on a trailing antenna of 600 ft. with a capacity of 0.0004 microfarad. Two large pliotrons requiring a filament potential of 18 volts and a plate potential of 100 volts are used.

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The British Association Meeting.

BRIEF REVIEW OF PAPERS DEALING WITH WIRELESS SUBJECTS.

Section A.

REPORT OF THE COMMITTEE ON RADIOTELEGRAPHIC INVESTIGATONS.

OWING to the restrictions on wireless work only a few communications have been received during the past year. Special experiments were arranged in connection with the solar eclipse of May 29th, with a view to ascertaining the effect of the eclipse on signals passing across the central line. Stations at Ascension and the Azores transmitted continuously whilst the shadow passed across the Atlantic, which it did in a direction from west to east, appearing first on the South American coast at dawn and traversing the Continent in half an hour. The speed of the shadow when near the equator was about one-third of a mile per second; this speed increased on the shadow crossing Africa. The eclipse finished at sunset near Madagascar. The effects of the moving umbra were examined under three heads:—(1) Strays, (2) Signals not crossing the denser parts of the shadow, (3) Signals crossing through or near the umbra.

Strays.

These were severe on the day of the eclipse and also on the preceding day in Europe, North America and the temperate latitudes of the Atlantic Ocean; they were severer in Central and South America and in Central Equatorial Atlantic. The meteorological conditions in Central America were exceptional, there being less rain on that day than on nearly every day of the preceding three weeks. A preliminary examination of the results obtained throughout the part of the globe from Constantinople to Rio de Janeiro indicates that no particular change in frequency or intensity of strays resulted from the passage of the shadow.

Signals not Traversing the Dense Shadow.

Arc signals of 4,700 metres wavelength transmited from the Azores were observed in Northern Europe and America at points extending from Berling through Holland, France, Italy, Spain and Great Britain to stations near the Atlantic coast and the United States. No unusual variations in the strength of these signals were noticed.

It was suggested that the well known "twilight" effect, that is, that at sunset or sunrise the twilight band when at one side of a transmitting station appears to strengthen as if by reflection waves received at a station on the other side of a transmitting station, might occur during an eclipse. Certain stations on the south of the central line of the eclipse were detailed to observe signals from a station which was also south of the central line. Stations at Durban and Port Nolloth found no trace of the said effect and in fact the observers at Durban concluded that the signals from Ascension grew worse after the eclipse began. Similar conclusions were arrived at by experiments on the northern side carried out by one of the sta-

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tions at Malta and also at Rosyth, which listened to Cairo.

Effect on Signals passing across the Central Line.

Special signals were transmitted from the Darien Station for observation by several stations in South America. These stations did not succeed in picking up the signals and the report from the Falkland Islands has not yet been received. Although fluctuations in the strength of signals occurred there was no steady increase or decrease in strength, whereas ships at sea within the penumbra, report an increase of strength of all signals during the eclipse. At Meudon and Rousillon (near Lyons) the signals from Ascension were received practically only while the eclipse was in progress and both Malta and Teneriffe found that the eclipse greatly improved the strength of signals. On the other hand, Darien failed to pick up Cairo, but Aden was picked up at greater strength than normal. Taken as a whole records show that an improvement in signal strength reached its highest value long before the umbra intervened between the stations and this value persisted after the umbra had passed. If the cause of the change in signal strength is an ionising process the results seem to indicate that this process is practically completed in a given region of space before the arrival there of the umbra.

DISCUSSION ON THERMIONIC VALVES.

This was opened by Dr. W. H. Eccles with a paper entitled "The 3-Electrode Thermionic Vacuum Tube and the Revolution in Wireless Telegraphy." In this paper he traced the development of radio-telegraphic practice from the days of spark transmission and reception by crystals or magnetic detectors. Parallel with this he dealt with the changes which antennæ had undergone, pointing out that whereas originally long-distance stations were forced to employ very large aerials it is possible to-day to use very much smaller antennæ for transmission and to receive practically without an antenna at all. He pointed out that in the thermionic valve is exemplified a method of obtaining electricity from matter without the use of machinery, and that a further development of this process may eventually lead to what will be the great need of the future, the obtaining of electrical power direct from fuel without steam boilers, engines or dynamos. He also discussed various well-known emitters of electricity and traced the development of the 3-electrode valve or triode and its applications in every branch of wireless telegraphy and telephony.

C. L. FORTESCUE urged the need for research of an organized and industrial nature and for research of the unorganised and spasmodic type, as carried out by the genius, and pointed out that for the physicist the valve offers fields for research of both these types. He discussed the filament of the valve in relation to the emission of free electrons, and dealt with the question of the efficiency of various materials as emitters. The remainder of this contribution to the discussion included references to various forms of the grid electrode and various processes involved in the manufacture of valves.

B. S. GOSSLING discussed a number of phenomena besides actual thermionic emission, and the effects of a mutual repulsion of the emitted electrons which are observed to enter into the action of the valve. These include the Maxwell distribution of velocities amongst the electrons, the contact potential between the filament and the

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grid, the composite electric field produced near the filament by the grid and anode and by the difference of potential between the two ends of filament, and also the orbits described by the electrons in the neighbourhood of the grid wires.

DR. R. WHIDDINGTON drew attention to the possibilities of using the Thermionic Valve in physical laboratories.

SIR OLIVER LODGE considered the possibilities of employing radio-active processes to bring about the emission of electrons in valves and also discussed the question of the utilisation of atomic energy by processes which might come to light as the result of our knowledge of electronic emission.

DR. W. MAKOWER also discussed the subject of bringing about electronic emission by means of radio-activity.

S. G. BROWN, with special reference to Dr. Eccles' remarks concerning lime-coated filaments, described some experiments which he made with a view to diminishing the difficulties encountered in this branch of valve manufacture.

WIRELESS IN THE ROYAL FLYING CORPS.

By Major T. Vincent Smith, R.A.F., M.C., M.I.E.E.

Dealt with the wireless work of the R.F.C. on the western front, covering the first three years of war.

WIRELESS METHODS OF MEASURING THE RATIO e/m.

By R. Whiddington, M.A., D.Sc.

Described the use of the Thermionic Valve in a new method of making this important measurement.

Section G.

DIRECTIONAL WIRELESS WITH SPECIAL REFERENCE TO AIRCRAFT.

By Capt. J. Robinson, R.A.F., M.Sc.

Described the system in vogue at the beginning of the war for the determination of bearings, which were (a) single coil, (b) method of the Bellini-Tosi system, (c) Telefunken clock. Described, further, the methods of determining position by the employment of bearings found by wireless which are: (a) transmission by aircraft to direction-finding ground stations, which take bearings on the aircraft and communicate same to a central station from which the position is transmitted when worked out; (b) the ground stations act as transmitters and are D.F'd. by the aircraft.

This paper also described the R.A.F. system of direction-finding.

A METHOD OF USING TWO TRIODE VALVES IN PARALLEL FOR GENERATING OSCILLATIONS.

By W. H. Eccles, D.Sc., and F. W. Jordan, B.Sc.

In the usual method of generating electrical oscillations with a thermionic valve, the oscillations in the closed ("flywheel") circuit are sustained by uni-directional pulses through the tube's external circuit. If two or more tubes are connected in parallel for the same purpose the output is not twice that of a single tube unless exceptional care is taken in the selection of the tubes and in the regulation of their grid voltages. Again, if the coupling is close there is a danger of producing asymetrical oscillations. The paper described an improved means of connecting two valves in parallel, whereby the "flywheel" circuit is influenced by a three-electrode valve and a H.T. battery symmetrically

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in every half-period. This can be accomplished by joining the grids of the valves by a coil which is connected to the oscillating circuit by its mutual inductance, by which means the resistance of one valve is caused to increase as that of the other decreases, with a definite phase relation to the oscillations.

A TRIGGER RELAY UTILISING THREE-ELECTRODE THERMIONIC VACUUM TUBES.

By W. H. Eccles, D.Sc., and F. W Jordan, B.Sc.

"In a well-known method of using a triode for the amplification of wireless signals an inductive coil is placed in the filament-to-anode circuit, and another coil magnetically coupled with this is introduced into the filament-to-grid circuit. This "back-coupling," as it is sometimes conveniently called, if it is arranged in the right sense, greatly exalts the magnification produced by the tube in any alternating E.M.F. applied to the grid; for the induced E.M.F. passed back to the grid is in correct phase relation to add directly to the original alternating E.M.F. applied there. If instead of using inductive retroaction of this kind we attempt to use resistance back-coupling, then the retroactive E.M.F. applied to the grid is exactly opposite in phase to the original alternating E.M.F., and the amplifying action of the triode is reduced. Since, however, one triode can produce opposition in phase in the manner indicated it is clear that two or any even number of similar triode-circuits arranged in cascade can produce agreement in phase. Hence we conclude that retroactive amplification can be obtained by effecting a back-coupling to the first grid from the second, fourth, and so on, anode circuit of a set of triodes arranged in an ohmically-coupled cascade.

It is possible to take advantage of the fact above stated for obtaining various types of continuously-acting relay."

The paper described a one-stroke relay, which, when operated by a small triggering electrical impulse, undergoes great changes in regard to its electrical equilibrium, and then remains in the new condition until re-set.

THE THREE - ELECTRODE THERMIONIC VALVE AS ALTERNATING CURRENT GENERATOR.

By Prof. C. L. Fortescue.

The first part dealt mainly with the work done during the war in the Wireless Telegraph Department of H.M. Signal School at Portsmouth. It traced the history of the Admiralty's early work and experiments with valve transmitters and referred to the names and performances of the various tubes used. The second part was a fairly simple account of the action of the valve as an alternating current generator, considerable use being made of hydraulic and mechanical analogies. In the third part the author went into the matter of the design of circuits and the fourth and concluding part embodied a description of certain valve transmitting sets as used by H.M. Navy.

INTER-IMPERIAL COMMUNICATION THROUGH CABLE, WIRELESS AND AIR.

By Sir Charles Bright.

In this paper the author discussed the general question of the Empire's communications, and urged the necessity for the introduction of the aerial mail, especially to Australia. In some instances the aeroplane can beat both the mailboat and the telegraph, and for the purpose of rapid communication between London and other important

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centres in England, where congestion of telegraphic traffic is likely to occur, the air route offers especial advantages. Treating of cable delays, Sir Charles referred to the national need for a modern high-speed British transatlantic line and stated that so far as working speed is concerned there is little to choose between a cable and an up-to-date wireless service. He might have added that there exists, in the Clifden-Glace Bay service, the British transatlantic high-speed line, the need of which he mentioned.

Sir Charles acknowledged the far-reaching and important technical developments of wireless communication, and expressed his opinion that these should be fully utilised in an all-British wireless chain without much further delay, and that all Imperial cable connections should be supplemented by wireless. Further, he advocated a highly-developed wireless news service " for the prompt and synchronous dissemination of news betwixt all branches of the Empire." Finally, he asked whether the inter-Imperial communication should not be put on the same footing with the Navy, Army and Air Force. inasmuch as it forms a most important strategic weapon.

Photo Topical Press.

The Magnavox, by means of which huge crowds heard President Wilson's Victory Loan appeal spoken by an aviator flying at a height of 3,000 feet.

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Notes of the Month

WIRELESS TELEGRAPHY IN PORT.

According to an announcement by the Ministry of Shipping arrangements have been made for wireless inter-communication between ships while in the ports of the United Kingdom. This will be greatly welcomed by shipowners who may now communicate with their ships in their own or other ports, employing for this purpose, ships lying in the owner's port.

* * *

NEW WIRELESS STATIONS.

The Minister of Public Works of Peru informs the public that the new Wireless Station at the Port of Eten has been opened for business. This station is now in communication with the large W/T station at Lima (San Cristobal) and at Iquitos, a town situated on the Amazon river. The Eten station is open day and night.

* * *

We understand that the Finnish State Council has approved of the erection of a Wireless Station of 35 kws. at Sandham, near Helsingfors, which should be completed in a few months. It is intended that its range shall be about 1,240 miles, thus permitting communication with London, Paris, and Berlin.

* * *

Several new long-range Wireless Stations are to be constructed by the Canadian Government on the Yukon River. A radiotelegraphic service has been established between Canada and Bermuda and between San Domingo (Dominican Republic) and Guantanamo (Cuba).

From "Lloyd's List," we learn that there has been commenced the erection of a high-power Radio Station at Point Hueneme. The station has been ordered by the United States Naval Department, and is to be one of a chain of similar stations on the Western coast of America, from Alaska to the Mexican border, and are intended specially for the service of coasting vessels.

* * *

WIRELESS AND FLYING IN AMERICA.

It is announced by the American Flying Club that plans have been made for the erection of a chain of wireless stations across the Continent which will enable aircraft to be in communication with them at 30-minute intervals. The Club will work in conjunction with the Government which has already started a series of radio stations connected with the air mail service.

* * *

LECTURES ON VALVES.

A course of six lectures on Thermionic Detectors, Oscillators and Amplifiers in Telegraphy and Telephony will be delivered by Professor J. A. Fleming, M.A., D.Sc., F.R.S., University Professor of Electrical Engineering, on Wednesdays at 5 p.m., beginning Oct. 29th, 1919, at University College, Gower Street, W.C.1.

The course is open both to Members and Non-Members of the University. Fee: £1 11s. 6d.

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LONG DISTANCE COMMERCIAL SERVICE TO SHIPS.

It is announced that Marconi's high-power station at Poldhu is now again open for traffic to ships which are out of range of any other British Coast Station. Telegrams may be handed in at any postal telegraph office in the United Kingdom, at Marconi House, Strand, W.C., or at 1, Fenchurch Street E.C. The rate per word is 2*s.* 10*d.*

* * *

WIRELESS CLUB NOTES.

THREE TOWNS WIRELESS CLUB.

The report of the meetings of the above club during August and September, is as follows:—

August 29th.

The chair was taken by Mr. J. Jerritt, the lecture on Detectors being given by Mr. Lock who first explained the Hertz detector and then the coherer of Branly and Marconi, and Marconi's Magnetic Detector, models of the last two being kindly loaned by the Chairman. Next the lecturer dealt with the Lodge Coherer, the Crystal Detector, the Electrolytic Detector, and the Fleming valve.

September 7th.

This meeting was spent in Morse practice. The letter from the Postmaster General stating that permission to do certain classes of wireless work would be granted to suitable applicants at a fee of 10/- was read by the Hon. Sec.

September 11th.

The chair was taken by Mr. Voss, late R.F.C., and Mr. Rose (Hon. Sec.), lectured on a Chaffee Arc of his own construction. He explained the working and construction of the instrument and advised members to try and make a mechanical instrument to take the place of valves. New members were enrolled at the close of the meeting.

September 18th.

Chairman, Mr. J. Jerritt. Mr. Voss lectured on telephone receivers, dealing in turn with the Bell telephone, the ordinary "watch" pattern, and the telephone made by S. G. Brown. At this meeting the club membership fee was reduced to 5/- per annum.

September 24th.

Mr. Burrows lectured on relays and landline working. Mr. H. R. Hitchcock, Divisional Director of Industrial Training, consented to become a Vice-President of the club, Major Maldon having resigned on his appointment to the War Office.

The Club is open to visitors, and applcations for membership should be made to the Hon. Sec., Mr. W. Rose, 7, Brandreth Road, Compton, Plymouth.

* * *

NORTH MIDDLESEX WIRELESS CLUB.

August 12th.

Sec. Lieut. A. W. Hulbert, late R.A.F., lectured on Aviation Instruments. After briefly reviewing the pioneer work of Wright Brothers and Sir Hiram Maxim, the lecturer gave a few facts illustrative of the rapid strides made in aviation during the last few years. As a point of historical interest he mentioned a paragraph in an old flying paper which commented on the flight in 1912 of a Farman biplane with Sunbeam engine, piloted by a certain Mr. Jack Alcock! He then gave a brief outline of how and why an aeroplane flies and showed the importance of various instruments for navigating and controlling the machine. Messrs. S. Smith & Sons (M.A) Ltd., the aviation instrument specialists, loaned a complete set of instruments,

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The Amateur Position.

IN view of certain paragraphs which have recently appeared in the daily press indicating that a change has occurred in the amateur position, we give hereunder a complete description of the facilities at present available for amateur wireless work, brought up to date (Oct 21st).

(1) All amateur licences have been cancelled and new ones are not yet being issued.

(2) Special informal permission to use receiving apparatus is being granted, and the following is the official statement regarding this :—

EXPERIMENTS IN WIRELESS TELEGRAPHY.

AUTHORITY FOR THE USE OF RECEIVING APPARATUS.

CONDITIONS OF ISSUE, Etc.

Formal licences to conduct experiments in wireless telegraphy cannot at present be granted: but, pending the settlement of certain outstanding questions, the Postmaster General is prepared to authorise the use of wireless apparatus for the reception of signals on the following conditions :—

(1) The applicant shall produce evidence of his British nationality and two written references. (A certificate of birth should be furnished if possible; but this will not be insisted upon if the two referees testify of their own knowledge that the applicant is of British nationality. The references should be given by persons of standing, who are British subjects and not related to the applicant);

(2) There shall be no divulgence to any person (other than properly authorised officials of His Majesty's Government or a competent legal tribunal) or any use whatever made of any message received by means of the apparatus;

(3) The installation shall be subject to the approval of the Postmaster-General;

(4) The aerial shall not exceed the undermentioned maximum height and dimensions :—

Extreme height of aerial above ground	100 feet.
Total length of wire including leading-in wires.	100 feet for single wire aerial. 140 feet of wire where two or more wires are used (*e.g.*, total length of 70 feet of double wire.)

(5) Thermionic valves shall not be used without the special authority of the Postmaster-General;

(6) The apparatus shall be open to inspection at all reasonable times by properly authorised officers of the Post Office;

(7) A fee of 10/- shall be paid. (It is contemplated that an annual charge of 10/- shall be made in respect of each experimental receiving licence to cover the expenses of the issue of the licence and the inspection of the station.)

PROCEDURE TO BE FOLLOWED.

The applicant should furnish

(*a*) A formal acceptance of the foregoing conditions;

(*b*) Evidence and references as described in (1);

(*c*) His full Christian names and particulars of his occupation;

(*d*) A remittance of 10/-;

(*e*) A description of the apparatus which it is proposed to instal, and, if authority is desired for the use of thermionic valves, a diagram of the circuits in which they would be used;

(*f*) A sketch showing the form, height and dimensions of the proposed aerial (including leading-in wires);

(*g*) The address at which the apparatus would be installed.

If it is desired to purchase wireless apparatus for use under the prescribed conditions full particulars of the apparatus, and the name and address of the firm from which it is proposed to obtain it, should be furnished, in order that a permit for its purchase may, if necessary, be issued. Any receiving apparatus belonging to the applicant, which is in Post Office custody, will be returned to him as soon as authority is granted for its use.

N.B.—If the applicant is a minor, the authority to use wireless apparatus can only be issued in the name of his parent or guardian, who should comply with the requirements set forth above and state his (or her) full address and relationship (if any) to the applicant. Evidence should also be furnished, as indicated in condition (1), of the minor's British Nationality. There is no objection to a minor working the authorised apparatus as the agent of his parent or guardian.

(3) No licence or permission to transmit by wireless telegraphy is at present obtainable by amateurs, as the conditions under which this will be allowed are not yet settled.

We shall keep our readers fully informed of further developments.

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including compasses, which materially contributed to the success of the lecture. The most interesting instrument demonstrated was the new Smith density meter. As all pilots know, the ordinary air speed indicator under-registers on height. The density meter is engraved with certain factors which show the correction necessary to obtain a true air speed irrespective of altitude and temperature. The lecture closed with a few references on the future of commercial aviation.

* * *

Wireless and Experimental Association.

In spite of the restrictions upon wireless apparatus retarding the practical side of the programme, a review of the activities for the past month of the Wireless and Experimental Association of 16 Peckham Road, S.E., is not at all displeasing. A series of very interesting and useful lectures have been delivered during the course of the month and among other things, the following may convey some idea of the general utility of the subjects chosen for the lectures. Induction and Induction Coils, Variable and Fixed Condensers, Valves, Detectors, Accumulators, W/T Headphones, Measuring Instruments (volt and ampere meters), Ebonite and brass-working and finishing, etc.

Several members have already been granted permission for reception work, and the Committee of Management hope to be in a position to commence experimental work and to erect a valve-reception Station on the Association's premises in the very near future.

By the time this notice appears in print, it is hoped that the workshop will be in full swing. It will be at the disposal of members every evening and a very interesting and profitable output is anticipated.

South London readers who are interested, are invited to make application for membership. The Secretary, Mr. F. H. Gribble will be pleased to welcome new comers any Wednesday evening between 7.30 and 10 and will be pleased to answer an enquiries by post, if directed to his address, 48 Surrey Square, S.E.17.

* * *

Wolverhampton Wireless Telegraph and Telephone Association.

Wolverhampton readers will be interested to hear of the formation of a Wireless Telegraph and Telephone Association in that district.

Intending members should communicate at once with Mr. Arthur Lawton, Essington House, nr. Wolverhampton, who is acting as Secretary pro tem.

* * *

WIRELESS SOCIETY OF LONDON.

The Wireless Society of London, we learn on going to press, had intended holding their Annual General Meeting early in October, but the Railway Strike caused unforeseen delay. However, the meeting, from what the Secretary informs us, promises to be an important one, and, in addition to the ordinary business, and the future policy of the Society, which will come under discussion, there is to be an Exhibition of Wireless Apparatus, so that those who have been out of touch with Wireless Telegraphy during the war will have an opportunity of seeing the seeing the strides that have been made in this Science during the past five years. One of the most important matters that will come under discussion is the practicability of affiliation between Provincial Societies and the

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Wireless Society of London, and in this respect, the Secretary tells us that on a recent visit to the " Powers that Be " at the General Post Office, the suggestion met with whole hearted approval.

In spite of the fact that there has been considerable delay in the granting of permits, the Secretary of the Wireless Society was assured that the Post Office in no way intends to limit the energies of the amateur or experimentor, providing always that reasonable care is taken in the use of thermionic valves for reception. Indeed, where an applicant shows that he has any knowledge of the apparatus he is intending to use, a permit to use valves has in all cases been given.

The International Communications Committee had before them (early in October) the definite proposals from the Postmaster-General as to conditions under which transmitting and receiving licences should be given, and possibly by the time this is in our readers' hands, these conditions may be approved.

The Advisory Committee of the Wireless Society, consisting of Mr. A. A. Campbell-Swinton, F.R.S., Professor G. W. Osborn Howe, D.Sc., M.I.E.E., Professor Ernest Wilson, M.I.E.E., and Dr. Eccles, M.I.E.E., have been accepted by the Secretary of the Post Office to advise on the suitability of applicants for transmitting licences, and members desirous of making application for such licences would be well advised to get in touch with the Secretary (Leslie McMichael, 30 West End Lane, West Hampstead, N.W.), giving particulars which will enable him to place their application before the Committee for recommendation.

The Society has recently been honoured by the addition of Admiral of the Fleet, Sir Henry B. Jackson, G.C.B., K.C.V.O., F.R.S., to their already distinguished list of Vice-Presidents. Sir Henry Jackson is, fortunattendance in Commttee, and has been ately for the Society, able to give his present at many recent meetings.

Club rooms in a central district have been practically decided upon, and here the apparatus belonging to the Society will be installed, and it is hoped a licence obtained in the near future.

The Presidential Address will take place in January and further particulars as to this will be given shortly.

A NEW ERA IN WIRELESS

By J. E. Catt.

Professor Chunder Bose has discovered that plants receive and respond to wireless waves.

By way of the dahlia
Comes news from Australia
Of the death of a famous D.D.;
While the sensitive aster
Relates that disaster
Has befallen a liner at sea.

In far Patagonia—
So says the begonia—
They're having political jars.
But the plant to attract us
Will be the first cactus
That picks up a message from Mars.

(H. J. H., in the *Daily News.*)

The term "Wireless Plant" has long been used, but in view of the recent discovery that certain flora are sensitive to the longer æther waves, as used in wireless telegraphy and telephony, enterprising seed specialists may be tempted to add to their catalogues a section as follows:—

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GROW YOUR OWN WIRELESS STATION.

ELECTRON, ION & CO.

Specialists in tested seeds for Wireless Plants.

Climbing French Beans.

These attain a height of six feet and are very useful as aerials. TRY OUR SPECIAL 5, 6 or 7 " spud " AMPLIFIERS.

ONION SETS.

As it is only recently that onion growing from sets has become popular, it may perhaps be as well to explain that the "set" is a small, specially-ripened bulb and may therefore be called a single-bulb transmitter. These sets, although very small, have an exceptional range owing to their good radiation. They should not, however, be used in the vicinity of a visual receiver as a bad damping effect will be experienced in the eyes.

DETECTORS.

Chrysanthemum Segetum Grandiflorum.

Super-sensitive, replaces carborundum and needs no potentiometer. Being a hardy annual it only needs to be set once in the best ground earth.

Cyclamen Persicum.

Can be used as a substitute for Zincite-Bornite or Silicon-Carbon.

Galega Officinalis.

Substitute for Galena. A good detector for amateurs.

Mimosa Pudica (better known as the sensitive plant).

A very popular plant which has earned its name by its sensitivity.

MISCELLANEOUS.

India-rubber Plant.

A stock of these should be kept for insulating purposes.

Convolvulus.

This plant is very useful for winding inductances.

Sweet Peas, Afterglow. Violet and electric blue with shading of rosy amethyst, quite distinct, or

Glow-worm. Lovely shade of salmon pink.

Both very useful as radiation meters.

Banana. Noble foliage plant.

The leaves of this plant are used for making condensers.

Beet.

Unsurpassed for the reception of continuous waves.

Leeks, various.

For use with grid condensers.

Capsicum Chili.

For heating valve filaments.

Spring Onions.

For suspending detectors. Very good shock absorber.

Iris (Kaempferi).

Popularly known as "Flags." These plants can be trained to receive and translate wireless signals into "iddy-umpti" or semaphore. They should not be used near the set, transmitting, onion, for use of, 1.

Eschscholtzia,
Lynchnis Arkwrightii,
Calceolaria Veitchii,
Habrothamnus Elegans,
Xeranthemum.

A few of the above plants should be kept at hand for Morse practice.

Viscaria Oculata Azurea.

The last word in wireless sets. Very useful at séances owing to its ability to detect waves from other worlds.

Funkia Sieboldii.

Only a few of these transmitters are left. They make good souvenirs, having been captured from the Huns on the Western front.

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Aircraft Wireless Section

Edited by J. J. Honan (late Lieutenant and Instructor, R.A.F.).

These articles are intended primarily to offer, as simply as possible, some useful information to those to whom wireless sets are but auxiliary "gadgets" in a wider sphere of activity. It is hoped, however, that they may also prove of interest to the wireless worker generally, as illustrating types of instruments that have been specially evolved to meet the specific needs of the Aviator.

AIRCRAFT WIRELESS SETS.

SPARK TRANSMITTERS.

SPARK TRANSMITTERS.

THE 52A.

THE 52A was fitted to the Vickers - Vimy machine that flew across in June, but it got no chance, as the wind-screw blades of the alternator were sheared off shortly after taking the air.

This emphasises the importance of care in making the initial installation, and of skilful handling thereafter. A wireless set has to be adapted to each bus, much as a suit is fitted to a man. It is hopeless to expect efficient results from aircraft sets unless skilful attention is given to fitting and maintenance.

The 52A has been used to a considerable extent on war work, and, given proper attention, has proved itself an efficient instrument within the limits of short-range work. As will be seen from the outline diagram shown in Fig. 19, the arrangement is very similar to the No. 1 Transmitter with the exception that the make and break is replaced by an alternator driven by means of a wind screw placed in the slip stream of the propeller; otherwise the principle of the set is the same as the No. 1.

The alternating current flowing in the primary of the closed-core transformers when the key is depressed induces corresponding high voltages in the secondary, which being applied across the condenser break down the spark-gap, and so form a high-frequency oscillating circuit comprising the gap, the condenser, and that part of the inductance tapped off by the clip A. The open or radiating circuit is auto-coupled to the closed circuit by means of the adjustable clip B. The inductance is of the helix ribbon type, as will be seen in the photograph, Fig. 20.

The closed circuit is set to any given wavelength by means of the clip A, the inductance helix being calibrated as in the No. 1 set. The degree of coupling is determined by the position of the clip B.

The alternator is self-exciting, and generates 200 watts at 20 volts, giving a range with good crystal reception of between 30 and 40 miles. It is designed to generate the required output at a speed of 4,500 revolutions per minute, giving with an eight-pole machine a note frequency of 600 per second.

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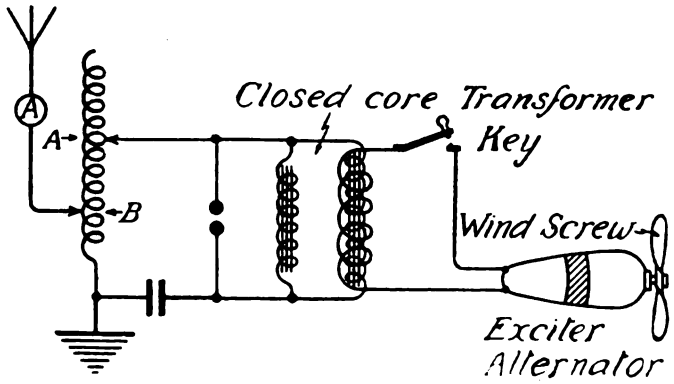

Fig. 19.

The size of wind screw that should be fitted will depend upon the normal air-speed of the bus in question. A certain amount of "regulation" to meet periods of abnormal speed can be secured by adjustably mounting the alternator so that the direction of the wind-screw axis can be varied relatively to that of the slip stream.

Though the transmitter is of small power, yet the aerial voltage reaches a value quite sufficient to justify a certain amount of care in the investigation of any irregularities whilst in the air. If a predilection for sitting on the key and " sleuthing " for faults cannot be overcome, the use of leather gloves will be found to minimise any consequent irruptions of blue smoke and heated language.

A further point of interest may be mentioned in connection with the wind-screw. As the key is depressed to send a " dash," the load placed on the alternator tends to slow it down, and thereby cause a "droop" in the note received in the phones. In order to prevent this, it is necessary to see that the wind-screw blades are of sufficient length to give the necessary reserve of power to maintain a speed of 4,500 revolutions per minute whilst under load.

This can only be satisfactorily determined by actual trial in the air, but the point should be borne in mind when installing the set in any particular type

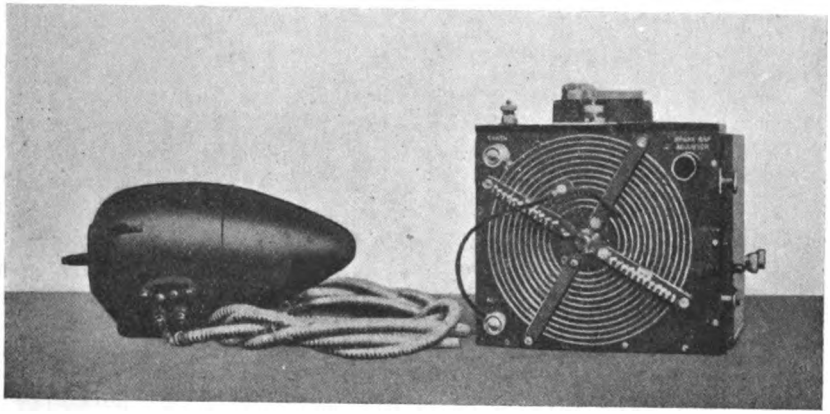

Fig. 20.

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of bus, as it will probably save one or more superfluous testing flights.

EXCITER-ALTERNATOR.

The alternator is contained in a stream-line aluminium casing and weighs about 8lbs. It is excited by means of a small direct-current shunt-wound dynamo, the armature of which is mounted on the same shaft as the rotor of the alternator. Both stators are fixed to the stream-line casing. The two power leads and the two exciter leads are brought to a four-way socket to which connection is made externally by a corresponding plug. One brush of the exciter, and the negative lead of the rotor winding, are earthed.

WEIGHT.

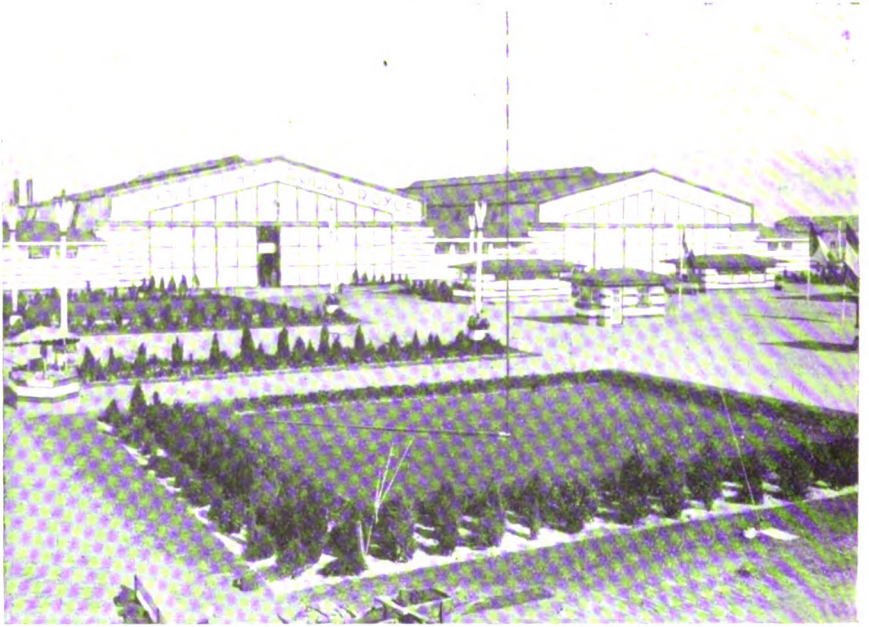
The outstanding merit of this set is its compactness and lightness. The whole set, including the generator, weighs only 30lbs. It is one of the earliest of the air-driven alternator type, and is perhaps the most efficient light-powered spark transmitter yet designed for aircraft work.

(To be continued.)

The Amsterdam Aircraft Exhibition.

The first Dutch Aircraft Exhibition which closed on September 14, was an undoubted successs, and the British exhibits in particular were representative of all sections of aircraft production from large passenger-carrying machines to the smallest accessories connected with aircraft in general.

The Marconi Company had a large number of instruments on view, and these were particularly well displayed on a commodious stand which faced the



The Wireless Mast will be observed in the foreground, while in the open space to the right of the picture the Marconi Wireless Telephone Station can be seen.

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main entrance to the Exhibition Hall. The stand was in charge of Mr. J. M. Poyntz, and to quote *Flight*, it was " one of the most interesting in the Exhibition."

The chief features of the Marconi display was the new Aircraft Telephone. This instrument, which is the most powerful of its kind yet produced, was subjected to a series of demonstrations on both Dutch Army planes and Dutch Navy seaplanes with complete success. In the grounds of the Exhibition a Marconi Ground Telephone Station was erected, and this provided a link between the ground and the various machines in flight.

Conversations were exchanged by leading officials in the Dutch Army, Navy, and Air Force, including the War Minister, various Generals and Admirals.

On the occasion of the visit of the British Airships R.32 and R.33, complimentary messages were exchanged between the ships and the Dutch War Minister.

The general results of these exhibitions went a very long way to impress on the Dutchmen the possibilities of the Wireless Telephone and the fact of its being a very valuable asset to any type of flying machine, for linking it with the ground during flight.

A large Handley Page flew from Cricklewood to Amsterdam shortly after the Exhibition opened. This machine was equipped with both the Wireless Telephone and the Marconi Direction Finder. It was hoped to give the public an insight into the working and use of these appliances in flight, but unfortunately the Exhibition Aerodrome proved too soft for this type of machine, and on landing her wheels stuck and she tipped on her nose. In view of the state of the ground she was almost immediately flown back to England and the Direction Finding Exhibitions had to be abandoned.

The Exhibition Authorities are to be congratulated on the results of their efforts, and the success of the British Section in particular was due to the untiring work of the London Organizing Manager, Mr. Van der Steen.

Interior of the Marconi Exhibition Wireless Telephone Ground Station.

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Aviation Notes

REGULATIONS FOR WIRELESS COMMUNICATION WITH AIRCRAFT.

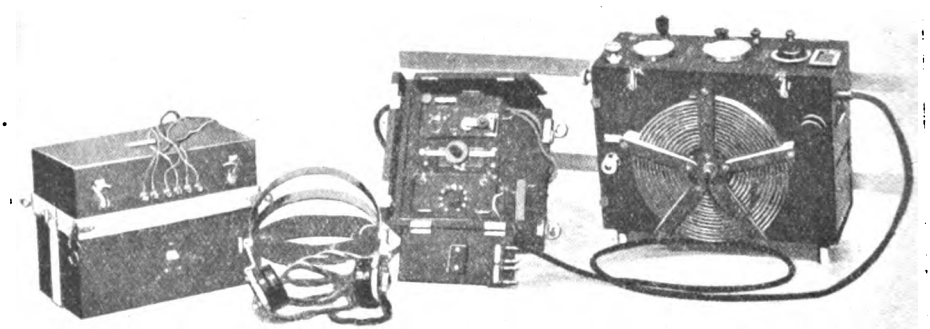
IT is interesting to note that this matter is at last receiving the attention of the powers that be.

The actual form of licenc necessary for the use of Wireless to and from Aircraft, and the precise conditions under which licences will be granted, have still, however, to be determined. But in the meantime temporary and provisional authority for the installation and use of wireless apparatus in aircraft can be obtained, in approved cases, from the Secretary of the Post Office.

Transmitters.

The sending apparatus installed at any aircraft station shall be constructed so as to be capable of using waves of 600 metres "interrupted continuous wave," and 900 metres continuous wave. But the following wave-lengths namely, (a) 220, 300, 450, and 800 metres "interrupted continuous wave," and (b) 200-550 metres, 650-950 metres, 2,000-3,000 metres continuous wave may also be used for transmission under the written authority of the Postmaster General.

The use of the wave of 600 metres is to be confined to Tonic Train, or "interrupted continuous wave" and the



Type 52 Transmitter (early battery-driven model) combined with Tb Receiver and Brown's Relay for Aircraft Work.

For the present the wave-length suggested for telephony work is 480 metres, which is the length employed for aircraft work by existing Air Ministry W/T stations.

For the information of designers, and other interested persons, it may be stated that the P.M.G's licence, when available, will probably contain the following conditions.

900 metres wave-length must be used only for continuous wave or Wireless Telephony.

Receivers.

The range of wave-lengths for which the receiving apparatus may be constructed is not limited, but the apparatus must be capable of receiving on 600 metres and 900 metres. It must also be made to embrace any other

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wave-length for which an authorized transmitter is installed.

Power.

The input of power to licensed apparatus, measured at the terminals of the power generator or battery, must not exceed 100 watts. However, when valves are used either in sending or receiving apparatus, the power employed for heating the filaments is not included in computing this maximum unit.

* * *

DIRECTION FINDERS FOR AIRCRAFT.

In a paper read before the British Association at Bournemouth last month, Captain J. Robinson, R.A.F., gave an interesting account of the development of modern direction-finding apparatus as applied to aerial navigation.

After reviewing the wireless installation for determining aerial bearings that were known at the beginning of the war, such as the single-coil, and Bellini-Tosi systems, he pointed out the inherent difficulties of such minimum methods where engine noise and magneto "clicks" prevented the attainment of the necessary accuracy in determining the zero signal point.

It was to obviate this disadvantage that he devised the Service system of using a main and auxiliary coil, mutually at right angles and rotatable about a common axis.

In operation, one coil is first used alone as a "searcher," and when this is giving approximately maximum signal strength, *i.e.*, is roughly in the plane of the advancing wave, the auxiliary coil is switched in, first in opposition to, and then in series with, the searcher coil. By swinging the system through a small arc under these conditions, and continually reversing the switch from the auxiliary coil, a well-

Capt. J. Robinson, M.B.E., Ph.D., M.Sc.

defined point can be ascertained at which the auxiliary coil, when inserted either in series or reverse, makes no difference to the signal strength received. The searcher coil is then accurately in the plane of the incident wave, and consequently pointing towards the transmitting station.

Two methods of installing the set were employed. In one, both coils were mounted on a pivot in the fuselage to rotate independently of the machine. In the other system both loops were fixed rigidly to the wings and structure of the machine, the plane of one coil being set at right angles to the plane of the other. With this arrangement the aeroplane itself must be "swung" during flight in order to ascertain the bearings. In practice, many long distance bombing machines carried both installations, the latter system being particularly convenient for " homing "

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or flying directly towards a given beacon station.

Reference was made to the means employed for cutting out "magneto noise," arising from the interference of short electromagnetic waves emitted by the magneto of the engine.

Quadrantal error, due to re-radiation from the metal work of the metal work of the aircraft, is determined by a preliminary "swinging" of the machine, much in the same manner as compass deviation is corrected in the case of a ship.

A further trouble arises from obscure refraction effects which vary with at mospheric conditions from day to day.

In spite of these many difficulties, Captain Robinson pointed out that excellent results have been obtained with the service system of wireless navigation.

In a particular test flight from the Biggin Hill experimental station to Paris, and back from Paris to Brighton, the machine was kept well above the clouds for most of the journey. In addition, the navigator was so placed that he could not look out of the machine The course taken was therefore made entirely dependent upon the bearings taken by means of the wireless installation. The result was entirely satisfactory. The navigator was not only able to determine the force and direction of the wind, and set an accurate course, but succeeded in forecasting the hour of arrival at his destination within two minutes of the actual time taken.

* * *

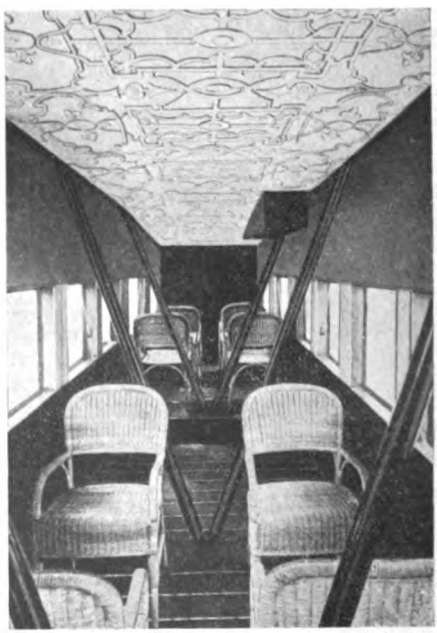
THE AIRWAY AND THE STRIKE.

The wonderful manner in which road locomotion was organized and rapidly adapted to meet the awkward situation created by the sudden Railway strike was, perhaps, the outstanding feature of that little episode.

But the part played by aviation in the sudden deficit of ways and means of conveyance was by no means negligible. The youngest transport service pulled itself together in good style, considering all the circumstances and succeeded in playing quite a useful part in the emergency.

In particular a regular postal delivery system was carried out from the Hounslow Aerodrome, linking up the Metropolis with Glasgow (5 hours), Newcastle ($3\frac{1}{2}$ hours), Manchester ($2\frac{1}{2}$ hours), Birmingham ($1\frac{1}{2}$ hours), and Bristol ($1\frac{1}{2}$ hours).

The charge made for letters and parcels was the ordinary rate plus two shillings an ounce. Rather stiff, considered merely as Cupid's mail, and calculated, perhaps, to cramp the flowing style



Interior of Two-engined Handley Page Machine showing the comfortable passenger accommodation.

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favoured by the ardent lover. But reasonable enough, as evidenced by the amount carried, in the case of important business correspondence where thousands of pounds may depend upon the safe and prompt delivery of a single letter.

One single Handley Page machine on the fourth day of the strike took 1,400 pounds of postal matter to Brussels for Holland and Norway, and made the return journey with a similar cargo of 2,000 pounds.

Passenger service by the airway was extended in all directions. In spite of the cost of this method of transit, many more craft could have been employed in this work than were available for service.

* * *

THE LONDON FLYING CLUB.

Another sign of the times is to be discerned in the establishment of this new organization for the flying man. Its Headquarters are at Hendon, and its main object is to provide a definite and organized centre for all interested in aviation.

The Club hopes to prove itself a useful factor in promoting the cause of the aerial traveller generally, whilst primarily maintaining all the essential features of a social and sporting institution.

The premises are most commodious and comfortable. Tennis courts, a shooting range and gymnasium, swimming-bath, ice-rink, and golf course, promise sufficient side recreation, whilst the lucky possession of his own bus will not only secure garaging facilities, but will also be able to make arrangements to have the main object of his affections carefully tended and kept in running order.

A school for tuition in flying will be available, and a selection of buses for hire. The formation of an institution of this kind augurs well for the future of flying, and it is to be hoped that the initiative shown by its promoters will meet the general support that it merits.

* * *

AERIAL WARFARE À LA FOKKER.

M. Fokker, the Dutch aeroplane expert, who proved himself so useful to the Huns during the late trouble, has, after chewing the cud of reflection for some time, disclosed the following gem of German aspiration.

Referring to the possibilities of aerial warfare, he declares that he and Fritz would have so employed the aeroplane as to make all our gunners look old-fashioned.

The idea was to build a very cheap aeroplane with a still cheaper engine guaranteed to last four hours, train this contraption to fly under the control of wireless radiations, load it up with T.N.T., and send a squadron out in charge of one pukka bus, which would carry the wireless control transmitter and one perfectly good pilot. This fortunate individual would convoy his flock whither he listed, and would drop them as required upon selected targets.

The scheme was based upon the notion that the old-established artillery firm was much too expensive an institution in the circumstances to carry out the extensive distribution of high explosive and metal required. So with characteristic economy the alternative was formulated. There may be more in the conception than calls for mere ridicule. But however well laid, the egg was not hatched out, though it may "come up to scratch" in the forthcoming war under the management of M. d'Annunzio.

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The Library Table

THE PRINCIPLES UNDERLYING RADIO COMMUNICATION.

SIGNAL CORPS, U.S.A.

Washington : Government Printing Office, pp. 355. 55 cents (1919).

THIS book has been prepared by Dr. J. H. Dellinger, Dr. F. W. Grover, Professor C. M. Smith, Professor G. F. Wittig, Dr. A. D. Cole, Dr. L. P. Wheeler, Professor H. M. Royal of the Bureau of Standards for the use of the Signal Corps of the U.S. Army. Essentially it is an instructional book rather than an exhaustive text book, aiming at presenting briefly merely the elements and basic facts of electricity and magnetism such as are requisite to lead up to Radio Communication. In order to render the work suitable for the training as operators of students having little or no initial electrical knowledge, the opening chapters deal with the elementary facts of the electric circuit and the magnetic effects of the currents. With this aim in view also, the mathematical portions of the book have throughout been reduced as much as possible, and explanations given in many cases by the help of mechanical and other analogies.

There are six chapters dealing respectively with Elementary Electricity, Dynamo-Electric Machinery, Radio Circuits, Electromagnetic Waves, Apparatus for Transmission and Reception, and Vacuum Tubes in Radio Communication.

The bulk of the treatment of the subject is of a particularly clear kind, and of an easily readable type; while the majority of the figures are also clear, although very diagramatic. Owing, however, to its having been written primarily for the use of the U.S. Army Signal Corps the book deals essentially with radio from the American point of view, and in most cases the apparatus and instruments described are restricted to those of American manufacture or design. In this connection, too, a number of expressions and phrases naturally appear somewhat strange to the English reader, and the American nature of the book requires to be borne in mind by a student to avoid gathering somewhat erroneous ideas considered from the British standpoint of the meanings of certain words and phrases. A number of references to other works are given throughout the book, but naturally these are also nearly all to American books or U.S. Government publications. In the last chapter dealing with valves, a brief mention is made of Radio-telephony, but the methods given are limited to one circuit diagram showing a modulating and generating valve. Useful features in the appendix are a list of suggested experiments illustrative of the matter dealt with in the book with brief working instructions and lists of mathematical and diagram symbols used throughout the book.

A POCKET DICTIONARY OF AERONAUTICS.

By F. T. JANE.

London and Edinburgh : Sampson Low, Marston & Co., Ltd. pp. 64. 1s. 6d.

To practically every calling in life there is attached a more or less profuse vocabulary of technical terms, or shop slang, the appropriate employment of

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which constitutes an invaluable support to the proper dignity of the expert in his dealings with the uninitiated.

How much pleasure would be lost to the fond owner of a new motor bike if he were denied the privilege of obscure—and frequently over-loud—discourse upon the interior economy of his machine during the morning's train journey up to town. Similarly half the charm of golf would disappear with its awe-inspiring slang.

Aeronautics is no exception to the general rule. In fact, owing to the obtruse nature of the principles involved in construction and the many special auxiliary gadgets concerned, the airman has quite an unusual amount of terminological ammunition with which to cow the amateur into a becoming humility.

This book, however, comes to the rescue. It comprises most of the learned technicalities of the craft briefly, but carefully, explained with the help of four excellent diagrams illustrative of the pusher and tractor types of plane.

Its price is regarded as excessive for the privilege of being able to maintain an intelligent expression during a conversational outburst concerning "aerodonetics," "colonette bolts," "monosoupapes" and "slip ratios."

Nor is the lighter side overlooked, and the purchaser will be enabled to estimate the precise value of the ubiquitous "gadget" as contrasted with the "doo-hickey," the "gilguy" or the "quiff."

Moreover, the book is of a convenient size to enable it to be stealthily produced from the pocket should mental crisis occur.

A short glossary of English and French synonyms is given as an appendix.

The interpolation of pages of advertising matter within the domain of the dictionary proper is confusing, and tends to irritate the reader. A small point, but worth avoiding.

* * *

THE HANDY ELECTRICAL DICTIONARY.

By W. L. Weber, M.E.

London: S. Rentell and Co., Ltd., pp. 224. 1s. 3d.

This is a recent edition of a fairly well-known, useful little book. It contains several thousands of carefully-compiled definitions and seven pages of illustrations showing the conventional diagrammatic forms of electrical instruments, the whole work covering more ground than any dictionary of the same price (or thereabouts) that we have seen.

It is to be regretted that the compiler has with one or two exceptions omitted to include "wireless" terms, even wavelength being absent; electrical literature nowadays is generally so profuse in references to radio practice that the failure of this book to cope with the nomenclature of what is now a fairly established branch of electrical engineering is not a trifling defect.

With regard to the definitions themselves they are full and accurate, though, as an exception, an electron is described as follows:—"A word signifying amber, not obsolete, *but seldom used.* An alloy of gold and silver. *The throwing of electric particles from the cathode of a high vacuum-tube.*" The italics are ours.

Finally we wonder why the compiler includes "Damped Vibrations" and omits "Logarithmic Decrement," why he defines "Coherer" but not one of the numerous family of thermionic valves, and why he includes "Pith" but makes no mention of "Coupling" or "High-frequency resistance."

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Correspondence

To the Editor of the WIRELESS WORLD.

THE AMATEUR POSITION.

After reading your article under this heading in the July number of the WIRELESS WORLD, and drinking to the full your optimistic words, I was immensely bucked up, but to-day have had a serious relapse on reading in an evening paper "D.O.R.A. for 12 months yet."

To me this is a terrible shock and I know will be to thousands of others who glory in this delightful hobby and have looked forward to winter evenings in our homes listening to other parts of the world speaking, and trying to penetrate deeper the hidden mysteries of W/T.

Before 1914 I knew nothing about the subject, but the war changed most lives, and mine it changed to an enthusiastic follower of Marconi. How many of my late fellow R.N.V.R. friends are awaiting on the threshold of expectancy for D.O.R.A. to die, it is impossible to tell, but out of the vast number, I believe somewhere in the neighbourhood of 10,000, there are hundreds, and we have all held in our breasts more secrets than most people realise, why therefore should the Government not trust us now, so that we may still keep fresh in our minds the knowledge we have learned at our Country's expense, and have it at hand should she call us in the future.

Wishing your paper every success,

Yours faithfully,

G. HART HORWOOD,

Late R.N.V.R.

To the Editor of the WIRELESS WORLD.

SIR,

Has it occurred to any of your readers that an aerial that has become sufficiently charged up with "static" to produce a succession of sparks across the Earth-arrester or Anchor-gap is radiating plain aerial impulses while so doing?

Such impulses would produce *x*'s (of the type known as "clicks") quite strong enough to be detected by receiving stations many miles away from the cause of the "static."

On several occasions I have detected a series of clicks which could not be tuned out, but which appreciably strengthened up on a particular adjustment. My own impression at the time was that they were caused this way and that they roughly tuned up on the natural wavelength of the aerial producing them.

Yours faithfully,

WILLIAM D. OWEN.

To the Editor of the WIRELESS WORLD.

SIR,

I have read with interest in this month's WIRELESS WORLD the narrative by Lieutenant Durrant of his voyage in the R34.

I notice that he obtained 250 miles range with his spark transmitter which from the description appears to be the Service Type 52M Transmitter, 150 Watt.

I have also obtained a record with a similarly built set of a slightly larger power, viz., 230 watt, which I think will equal the above.

Whilst making a voyage on a "Motor Launch" (M.L.) from Dundee to Poole, I was exchanging signals with Dundee (Carnoustie R.A.F. W/T Station) at a distance of 320 miles on a wavelength of 330 metres. My last signal to Carnoustie was one giving my position as 90 miles S.45E. of Flamborough Head. At this time I was working under great difficulties. My Filament Battery for my Valve Receiver (Type T.F.) was so low that I had to take out the two amplifying valves and receive direct. Also my 18 volt Transmitting Battery was only giving 15½ volts and I had some difficulty in getting a fair spark. I was in communication with Flamborough Head up to a distance of about 130 miles, and was receiving Carnoustie (Dundee) at over 400 miles later on as we were passing Dover. It was about 3.30 p.m. on April 6th when I last communicated with Dundee and we arrived at Yarmouth Seaplane Station close on midnight.

On the next day (April 7th) I took my accumulators to be charged and was congratulated by the W/T Staff of Yarmouth, who expressed their opinion that I had obtained the record for the British Isles with this particular type of transmitter (52B Coil Set).

I would like to describe the Aerial I was working with. It was a "Four Wire Straightaway" 38 feet in length, one end being 30 feet and the other 48 feet above Sea Level.

With the aid of extra Inductances I was able to get several high power stations quite easily. I took the time signals from POZ regularly at 12-00 G.M.T. every day and took Paris press and time, also Poldhu weather report regularly throughout the voyage.

There is one question I would like to ask. Can you offer any explanation why in a Valve Receiver unlike the Crystal Receiver better results are obtained when the Detector Circuit is directly coupled to the Aerial Circuit instead of Inductively Coupled?

Yours truly

CYRIL E. BARNES.

Sgt., Mech. W/T.

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The Construction of Amateur Wireless Apparatus

This series of articles, the first of which was published in our April number, was originally designed to give practical instruction in the manufacture of amateur installations and apparatus, and arrangements had been made with Marconi's Wireless Telegraph Co., Ltd., to supply complete apparatus to the designs it was intended to detail. The restrictions on amateur work, however, have remained in force, and the author is compelled to proceed on general lines only. Please see the special notice at the end of this article.

Article Eight.—THE REACTION PRINCIPLE.

THE REACTION PRINCIPLE.

BEFORE entering into a brief discussion of the methods of receiving continuous wave signals and the generation of continuous oscillations by means of the three-electrode valve, it is necessary that the amateur should have a clear idea of the reaction principle and the method of applying it in practice.

In Fig. 1 we have illustrated the elementary high-frequency magnification circuit already explained. The tuned circuit *A* connected in the grid-filament circuit of the three-electrode valve, having induced in it the oscillations it is desired to magnify, the circuit *B* is provided to receive the magnified counterpart of these oscillations in the plate circuit of the valve. Now let us assign a figure to represent the magnifying power of the valve, the value of this constant being taken to indicate the ratio of the magnified current in *B* to that of the original or trigger current in *A*. In practical cases the numerical value of this constant may vary between very wide limits, being controlled by the design and mechanical construction of the valve itself. For the sake of this discussion we will assume that the value of the constant is ten. By this we mean that if a current of one microampere is induced in the circuit *A*, then ten microamperes will be found to be flowing in *B*. Now it is clear that so long as we maintain the steady oscillatory current of one microampere in *A* the current in *B* will also remain steady at ten microamperes, so that there is no objection to us using a portion of the *B* current to supply the energy for the *A* current. The method of doing this is illustrated in Fig. 2. It will be observed that a small coil *R*, is inserted in series with the inductance of the circuit *A* and that this coil is coupled magnetically with the inductance of *B*. Energy can now be transferred from *B* to *A via* this coupling, and it is obvious that, provided the coupling is adjusted to be in the right sense and of the right value the whole circuit will maintain itself

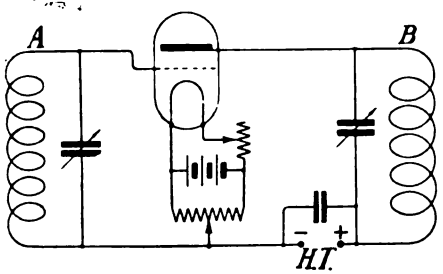

Fig. 1.

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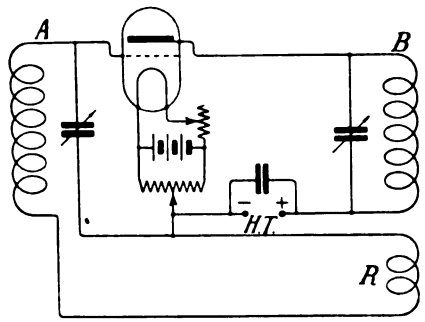

Fig. 2.

in a state of continuous electrical oscillation, one microampere flowing in *A* and nine microamperes in *B*. Of course, the amateur will understand that the actual phenomena occurring in an oscillating valve circuit are of a very complex nature; the above explanation is only offered as an aid to the clear understanding of the principle involved in reaction methods.

The first application of reaction occurs in the reception of spark signals. For this purpose we arrange the circuit so that a part of the magnified current can be transferred to the grid circuit and be employed to " boost up " the incoming signals. A spark circuit arranged in this manner is shown in Fig. 3. The circuit is identical with the crystal magnifier described in the last article with the exception of the addition of the reaction coil *R*. The arrangement is a very important one as it is one of the best that have ever been devised for single stage valve magnification. By accurate tuning of the circuits and a critical adjustment of the coil *R* a very high order of sensitivity can be obtained, and the amateur will, in general, find it all he requires for his spark receiving work. We have indicated the telephone directly connected in the crystal circuit *via* a telephone transformer; but of course, single or double note magnification can be added if it is desired. Note magnification does not largely increase the sensitivity of the arrangement, but has the effect of making signals which are too weak to read comfortably into strong, easily readable Morse. Note magnifiers have the grave disadvantage of magnifying signals of medium strength to a greater extent than very weak ones, with the result that atmospherics may become deafening crashes during bad periods. These very strong *x*'s have the effect of momentarily paralysing the ear and rendering it insensitive to weaker sounds, with the result that the general readability of the signals is reduced. It will therefore be seen that a high magnification (particularly low frequency) is not an unmixed blessing, and in practice one always employs the least amplification to render the signals readable. High note magnification is almost entirely used for the purpose of recording automatic sending at high speed.

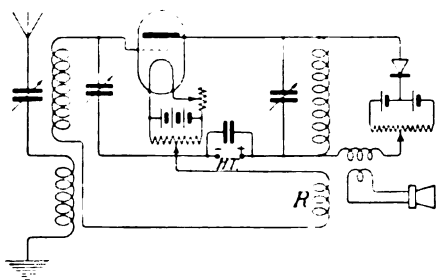

Fig. 3

Continuous Wave Reception.

The simplest and best method of receiving signals of this type is by the production of beat tones by means of the three-electrode valve. We shall not enter into the theory of the method, the reader must consult a suitable textbook for a description of the principle involved. (See " The Oscillation Valve," by R. D. Bangay.)

In Fig. 2 we illustrated a simple

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circuit, showing the manner in which the three-electrode valve can be made to sustain continuous oscillations in suitable circuits. In Fig. 2 it will be observed that we have shown both the *A* and *B* circuits tuned to the desired wave-length. In practice it is found that it is sufficient if *either* the *A* or *B* circuit be tuned. The remaining circuit then merely becomes a reaction coil without any condenser across it. For continuous wave reception the grid circuit must be tuned and coupled to the aerial; the plate circuit then consists of a reaction coil in series with a telephone transformer and the high tension battery. Such a circuit is generally known as a "self-heterodyne," the valve performing the three functions of rectifying, magnifying and "heterodyning" by the production of local oscillations. Fig. 4 shows the exact arrangement which may be used. The reaction coil R must, of course, be made adjustable in order that the right strength and sense of coupling may be obtained.

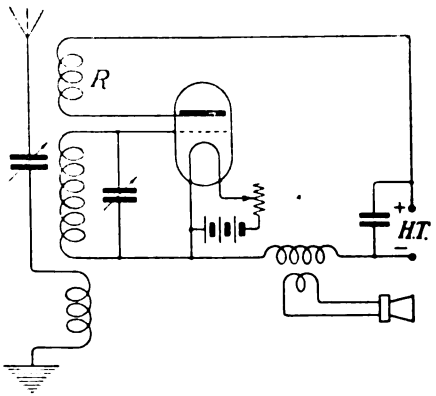

Fig. 4.

The incoming signals cause an oscillatory current to flow in the tuned grid circuit which is superimposed on the local current maintained by the valve; the compound current is then magnified and rectified by the valve and is heard in the telephone connected in the plate circuit. The practical working of the receiver is very simple. The reaction coil is adjusted until the circuit is oscillating, then the tuning condenser is turned until the characteristic whistle of a C.W. signal is heard. Of course it is necessary to follow any variations of tune by suitable adjustment of the aerial wave-length; but rough tuning of the aerial is only required in order to pick up a station, then the coupling can be weakened and accurate adjustment performed. We have described this arrangement as for the reception of continuous waves, but the amateur will find it very simple and useful for spark signals as well. Of course the pure note of the spark is lost, but the extreme sensitiveness of the circuit makes up for any loss of readability on this account. A little practice will enable the amateur to tell at once if the circuit is working properly from the sound of atmospherics. Immediately the circuit begins to oscillate, even if the aerial tune is a little out, a slight fizzling noise is heard. This sound is due to the magnification of small *x*'s and is quite characteristic. It is a good plan to adjust the reaction coupling by listening to this noise. The coupling should be such as to cause the circuit to oscillate freely, but should on no account be too tight, or the strength of signals received will suffer. It is not necessary to keep the grid tuning condenser very small; for waves of 2,000 metres and over the condenser may be ·003 mfd. or more.

A simplified circuit of the same type is shown in Fig. 5. In this case the grid circuit of the valve is connected directly across the aerial tuning inductance, adjustment of wave-length being obtained by means of the shunt condenser. For short waves the condenser may be placed in series with the aerial

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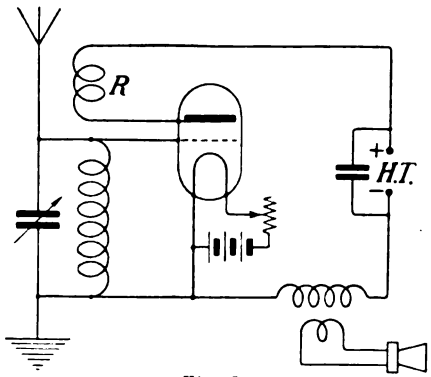

Fig. 5.

instead of across the inductance if desired. The chief advantage of the circuit lies in the fact that it is very easy to pick up any station since there is only one tuning adjustment to be made, that of the single condenser. There is sometimes a little difficulty in following the tune with both circuits when using the arrangement shown in Fig. 4. Of course, in common with all other direct coupled circuits, the receiver is very susceptible to jamming. The amateur can devise for himself an arrangement of switches to change over from circuit 5 to circuit 4 if he wishes, when circuit 5 becomes a convenient stand-by.

It will be noticed that we have shown no potentiometer in the last two figures, the bottom end of the grid circuits going directly to the negative end of the filament battery. When using most valves it will be found that by a suitable adjustment of the plate voltage, the best working potential for the grid can be made to coincide with the negative end of the valve battery and thereby the necessity of potential adjustment is avoided. This point also applies to all the valve connections we have illustrated and may be of importance to the amateur.

Continuous wave signals can also be received by the method of separate interference. The circuit we give below for the production of continuous waves can of course be used for the local oscillator.

PRODUCTION OF CONTINUOUS WAVES.

We have already pointed out that the fundamental reaction circuit shown in Fig. 2 can be made to oscillate by either tuning the grid or the plate circuit, and that for the reception of continuous wave signals it is only necessary to tune the grid circuit. Now when the arrangement is used for the production of oscillations for transmitting purposes we wish to get the maximum amplititude of oscillation possible with a given valve. The source of the high frequency energy is obviously the high voltage battery connected in the plate circuit of the valve, hence it is clear that the correct place to connect our tuned circuit is in series with the plate battery.

The first oscillation valve transmitters were connected as shown in Fig. 6. In this case the aerial is a separate tuned circuit and is coupled magnetically with the valve oscillatory circuits. We

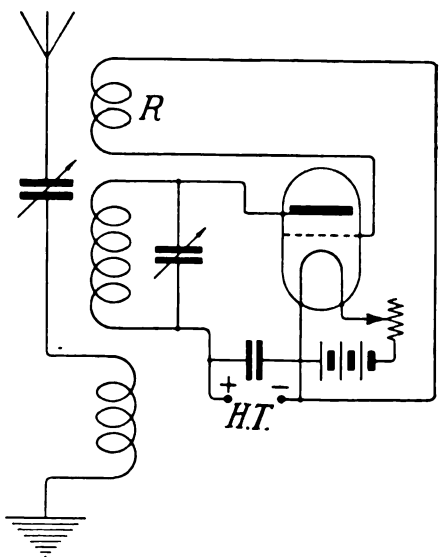

Fig. 6.

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do not recommend the connection to the amateur. It is difficult to manage in practice and liable to be unstable. The simplest circuit is the direct coupled one illustrated in Fig. 7. In this case the aerial is maintained in continuous oscillation directly by the valve. The condenser *C* is a reservoir condenser for the high voltage E.M.F. and also affords a path of low impedance for the oscillatory currents. Aerial insulation plays an important part in this circuit since the full voltage of the plate E.M.F. exists between the aerial and earth. Should there be any doubt as to the quality of the aerial insulation it is advisable to introduce a condenser in the position indicated by the dotted lines. A common circuit employed for transmission is shown in Fig. 8. We do not recommend this to the amateur, as a study of the figure will show that the valve filament battery, reaction coil and all associated apparatus have the full P.D. of the high voltage source between themselves and earth.

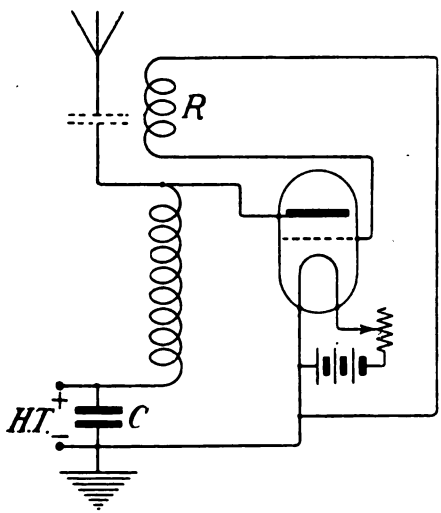

Fig. 7.

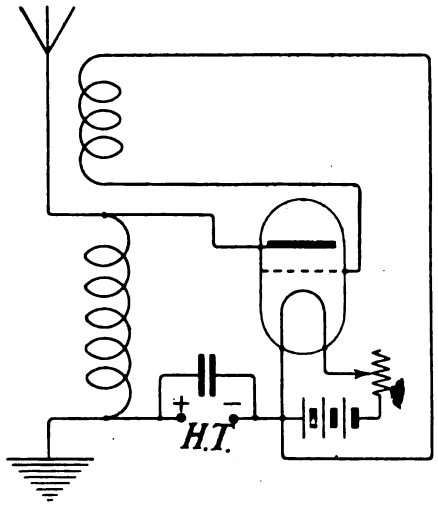

Fig. 8.

The type of valve to be employed, the source of high voltage supply, the sizes of windings and capacities of condensers must perforce stand over for discussion in a future issue. The reader will understand that we cannot enter into actual constructional details until the Government issue definite information as to the limitations they propose to apply to experimental work. In the meantime we shall endeavour to give the amateur general information which he will find of assistance in his work as soon as the issue of licences recommences.

SPECIAL NOTE.

Owing to the continued delay by the Government in deciding the lines upon which the wireless amateur will be allowed to work, we have been unable to execute our original plans of supplying detailed information for the manufacture of amateur wireless apparatus. Pending an announcement of policy by the authorities our contributor will continue the present series along the lines already laid down.

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Patent Section

124,786. Wireless Signalling. Artom, A., 18, Corso Siccardi, Turin, Italy. March 27th, 1916. No. 4518. (Classes 39 (i) and 40 (v).)

Apparatus for determining the direction of incident wireless waves comprises two or more coils mounted to turn in a permanent magnetic field and traversed by rectified currents from the respective directive receiving-aerials, or by local direct currents set up by, and proportional to, the currents in the aerials. As shown in plan in fig. 2, two coils *A B*, *C D* are mounted freely on a vertical axis and are connected through rectifying-detectors *K*, K^1 to the directive receiving-aerials, which are placed in vertical planes at right-angles. Permanent or electro magnets *NS*, preferably one for each coil, create a strong magnetic field in the space occupied by the coils, the field being directed by a vertical soft-iron cylinder 1.

FIG.2

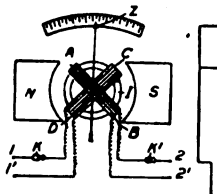
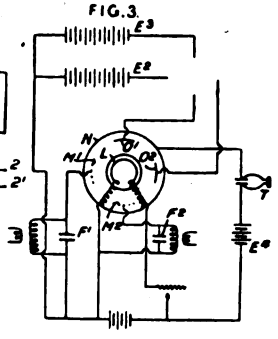


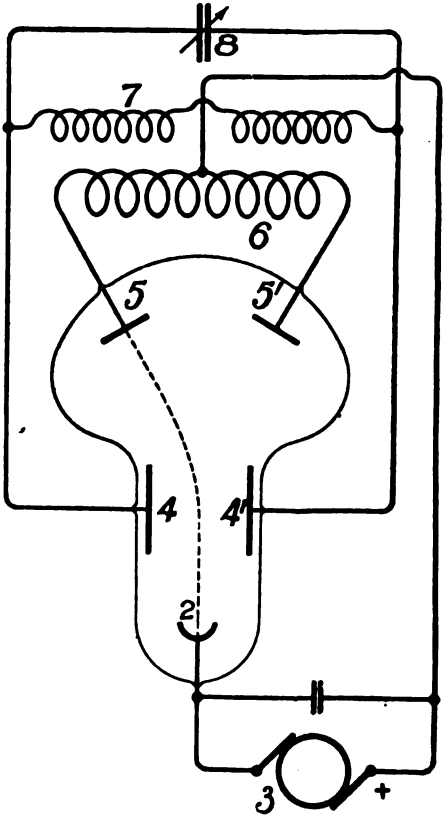
FIG.3.



A pointer *Z* moving with the coils indicates the direction of the incident waves on a scale, provided it is known from which quadrant the waves are arriving. The detectors may be of any type; for instance, hot-wire detectors in each receiving-aerial may influence thermo-couples connected to the coils *AB*, *CD*. When electrolytic detectors are used, all the electrodes are immersed in a single vessel containing acidulated water, etc. In the form shown in fig. 3, the directive aerials are coupled to oscillatory circuits F^1, F^2 which are connected on the one hand to the filament *L* of an ionized-gas tube, and on the other hand to adjustable grids M^1, M^2. The coils *AB*, *CD* of the direction-finder are connected through the terminals 1, 1^1, 2, 2^1 to the filament *L* and to two plates o^1, o^2 within the tube, batteries E^2,E^3 being placed in the respective circuits. A telephone *T* is connected through a battery E^4 to the filament *L* and to a cylindrical plate *N* in the tube. Specifications 23488/03 and 19805A/06 are referred to.

126,019. Producing Electric Oscillations. Bethenod, J., 10, Rue Auber, Paris. October 26th, 1916. No. 15274. Convention date, November 5th, 1915. (Classes 38 (ii), 39 (i), 40 (iv), and 40 (v).)

Electric oscillations are produced by means of a vacuum tube having a cathode, two anodes, and an alternating electric field by means of which a cathode beam is oscillated from one anode to the other. The alternating electric field is produced by the action of the tube itself. In the arrangement shown, a vacuum tube 1 is provided with a cathode 2 and two anodes 5, 5^1 connected to the terminals of a transformer winding 6. Two plates 4, 4^1, connected to the terminals of a transformer winding 7 and forming a condenser, are placed adjacent to the cathode beam. The negative terminal of a generator 3 is connected to the cathode 2, and the positive



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terminal is connected to the middle point of the winding 6. With the beam impinging on the anode 5, as shown, the current through the left-hand portion of the winding 6 causes the potentials of the terminals of the plates 4, 4^1 to shift the beam to the anode 5^1 when the potentials of the plates are again reversed to cause the beam to impinge on the anode 5, and so on, thereby causing undamped oscillations to be produced in the condenser circuit 8.

123,126. Vacuum tubes. Western Electric Co., Norfolk House, Victoria Embankment, Westminster (Western Electric Co., 463, West Street, New York, U.S.A.). January 8th, 1918. No. 411 (Class 39 (i)).

An electron-emitting cathode is made by coating a metal filament with a mixture of a thermionically active substance and a compound of a "noble metal," such as platinum, gold, or silver. Silver, if used, is volatilized before employment of the cathode. The noble metal compound is such as to be decomposed by heat, for instance gold or silver oxide, or ammonium chloro-platinate. Platinum increases the adhesion of the thermionic substance and the life of the filament. Two molecular parts of the platinum compound may be added to one molecular part each of barium and strontium oxides. Addition of calcium oxide further increases the life of the filament. Gold increases the electron emission; it may be used with a mixture of all three oxides, or with strontium oxide alone. Still higher emission is obtained by the use of silver, which may be employed in various mixtures; the filament can then be worked at low temperatures. The base filament, which may be of platinum or of an alloy thereof with similar metals is dipped in an aqueous paste of the coating substances in a moving trough and is then heated by currents. From three to five coats are thus applied, after which the filament is baked at 1000° C. for two hours when the coating contains platinum, or at 600-700° C. for 5-10 minutes in the case of gold and silver. Before use of the filament the silver is volatilized by passing current through the filament either in the completed vacuum tube or in a separate exhausted vessel.

Personal Notes

DEATH OF A WIRELESS PROFESSOR.

The death is anounced of Prof. D. Korda, Professor of Wireless Telegraphy and High-Frequency Machines at the Technical School, Zurich. The deceased was born in Hungary 55 years ago. He was associated with the construction of the first electric locomotive at the works of the Société de Fives-Lille, France.

* * *

NEW APPOINTMENT

Major Rupert Stanley, Fellow I.R.E., Professor of Electrical Engineering at the Belfast Technical Institute, who has been engaged in wireless work in the R.E. during the war, has recently been appointed the Principal of the aforementioned Institute.

* * *

WIRELESS MEN WIN DECORATIONS.

The following gentlemen, who served during the war in the R.N.V.R. (S.W. Section), have been awarded the Meritorious Service Medal. Chief Petty Officers H.C. Wills, A. Pink, E. Blake, A. E. Hill, G. H. Lambert, W. Pettengill, Petty Officer O. Tooth.

* * *

DEATH OF A MARCONI ENGINEER

We announce with deep regret the death of Mr. Alexander Wilson, M.E. which occurred at Ilford on Thursday September 25th.

Mr. Wilson has seen many years service as an engineer, and held prominent positions at home and abroad before joining the Marconi Company in December 1899. During his twenty years connection with the Company, and especially in earlier years, his mechanical knowledge and wide experience were most valuable.

Mr. Wilson was a widower and leaves two daughters.

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Questions and Answers

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless telegraphy. Readers should comply with the following rules:* (1) *Questions should be numbered and written on one side of the paper only, and should not exceed four in number.* (2) *Queries should be clear and concise.* (3) *Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before.* **(4) The Editor cannot undertake to reply to queries by post.** (5) *All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or if so desired, under a "nom-de-plume."* **(6) Readers desirous of knowing the conditions of service, etc., for wireless operators, will save time by writing direct to the various firms employing operators.**

N.F.E. (Warwick).—The diagram of connections shown in your first sketch is the best one for a three-electrode valve, with the exception that one side of the telephones must be connected to the side of the filament which is connected to the inductance coil. This will necessitate putting your filament battery on the other side of your filament circuit, *i.e.*, connect one side of battery to the resistance and the other side of the battery to the telephones.

You will probably find it much better to connect an adjustable tuning condenser across the secondary inductance. Do not make this condenser more than about .0003 mfd.

We notice that you include an aerial tuning condenser in series with your aerial. This will not be necessary unless you desire to receive wavelengths less than the fundamental wavelength of your aerial.

C.S. (Penrith).—It is not possible to give the strength of the magnetic field in the gap of a string galvanometer, as this figure is different for each make of instrument. The iron is, however, magnetised to a point past saturation point so that any small variation in the strength of the magnetising current will not effect the strength of magnetic field.

We do not think that an electrostatic string galvanometer could be used in conjunction with a rectifying crystal to measure high-frequency alternating voltages in the manner suggested. The resistance of the crystal being very high, it would in any case alter the calibration of the voltmeter so that the instrument would need re-calibrating. An ordinary high-resistance electro-magnetic string galvanometer may be used in series with a high-resistance crystal to measure H.F. voltages, if it is properly calibrated with the crystal with which it is to be used.

"SPARKS" (Dartmouth).—Asks: (1) If in a three-valve amplifier Ford ignition coils could be used as valve transformers? We think that Ford ignition coils could be used for this purpose if they are in good condition. The insulation resistance between the windings and between the windings and the core should not be less than about 200 megohms.

We expect, however that the ratio of the turns will not be the correct values, but it will make a good experiment to adjust these with the valves until the best result is obtained.

(2) What is the lowest voltage receiving valves will work with? Some valves work on quite low voltages of about 20 to 60, but possibly the majority of valves used at present work on about 100-150 volts.

(3) The price of a moderately good set as it has often been pointed out depends on the maker's ability and the means at his disposal. One man could make a set for a few shillings whereas the same set would cost another as many pounds.

(4) Small pocket lamp batteries can be used quite well for the H.T. battery for a valve. It is best to place the cells in a box, cardboard does quite well, and then pour melted paraffin wax round and over the tops of the cells. Another method is to put a layer or two of insulating cloth such as empire cloth round each cell. The advantage of this method is that any one cell can be easily replaced should it run down.

SHARE MARKET REPORT.

The market in the shares of the Marconi Group continues fairly active and prices are well maintained. Prices as we go to press (Oct. 15).

Ordinary £5 15s. 0d, Preference £5 5s. 0d, American £1 13s, 0d, Canadian 17/-, Spanish 12/6, Marine £3 1s, 3d

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Company Notes

THE MARCONI WIRELESS TELEGRAPH COMPANY OF CANADA, LIMITED

Annual Report and Statement of Accounts for Year ending 31st December, 1918.

Report of Directors.

The Directdrs herewith submit their Annual Report and Statement of Accounts for the year ending December 31st, 1918

During the period under review, gratifying development has been made in the equipment and operation of wireless apparatus on vessels of the Canadian Mercantile Marine. With the advent of the new merchant steamers operated by the Canadian Government Merchant Marine, Ltd., for which vessels your Company has secured the wireless contract, further development in this branch of our business is assured.

As a result of re-organization of our factory referred to in last year's report, the Company was able to cope with increased orders for wireless apparatus, and a favourable feature of the year's operations is the increased Works output and consequent improved revenue from our Factory.

Your Company had still to contend with adverse traffic conditions during practically the whole year, and Government restrictions on wireless working deprived the Company of much traffic revenue. After the signing of the Armistice on November 11th, 1918, a gradual relaxation of war restrictions took place. East Coast Stations, which had been closed down or taken over by the Canadian Naval Service Department, were turned back to the Company for operation and every effort made to rebuild a profitable service. During the concluding weeks of the year, revenue from this source showed great promise and your Directors look forward to increased returns in the future.

Immediately the Armistice was signed your Directors took prompt steps with a view to re-opening the Company's high-power Transatlantic stations at Glace Bay and Louisburg, and succeeded in securing permission from the British Admiralty to reopen stations on December 2nd, 1918. This sanction only permitted the Company to handle Press and Government messages and, although a fair volume of such traffic was secured, further pressure was brought to bear by the Directors, with a view to receiving authority to handle ordinary commercial traffic. After much negotiation, permission to accept commercial messages was obtained, but this authority was not secured from the Admiralty until March 10th, 1919.

Your Directors regret to state that, so far, no settlement has been arrived at with the Canadian Naval Service Department in respect of the Company's claim for compensation for the closing down of East Coast Stations for the period subsequent to August, 1916. Claim has also been presented against the British Admiralty for loss of revenue owing to the closing down of the Company's high-power stations at Glace Bay and Louisburg, and steps have been taken to press for an early settlement of same.

Mention is again made of the continued efficient services of your Company's trained employees in connection with the successful prosecution of the War. A considerable number of our skilled operators were employed on transports through the war zone, whilst many were loaned to the Canadian Naval Service for duty on East Coast Stations. Wireless sets for new vessels and special apparatus for the requirements of the Naval, Military and Air forces were designed, manufactured and installed by expert staffs in a manner creditable to your Company.

Respectfuly submitted,
J. N. GREENSHIELDS,
President.

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THE MARCONI WIRELESS TELEGRAPH COMPANY OF CANADA, LIMITED.

BALANCE SHEET - 31st December, 1918.

ASSETS

CURRENT ASSETS			
Cash		$3,437.22	
Accounts Receivable—			
Sundry	$193,671.21		
Affiliated Companies ..	52,189.71		
	$245,860.92		
Less—			
Reserve for Bad and Doubtful Debts	15,000.00		
		$230,860.92	
Investments—			
Dominion of Canada 5½% Victory Loan Bonds Subscription $11,500.00	4,660.00		
Dominion of Canada 5% War Bonds paid up ..	1,900.00		
French National Defence Bonds, Fcs. 16,100 ..	3,290.18		
Port Burwell Telephone Company	10.00		
		9 860.18	
Apparatus and Stores on Hand		112,594.47	
FIXED ASSETS			$356,752.79
High Power Stations ..	408,649.88		
Coast Stations	17,477.91		
Ship Stations	137,448.32		
Montreal Real Estate, Buildings, Machinery, School Equipment, &c.	105,590.33		
	$669,166 44		
Less Depreciation written off for year	18,216.89		
		$650,949.55	
Property Rights, Patents, Titles, &c.		4,991,881.03	
			$5,642,830.58
DEFERRED CHARGES			24,753.57
			$6,024,336.94

LIABILITIES

CURRENT LIABILITIES			
Accounts Payable, including accrued rent		$730,528.47	
Unclaimed Wages		21.01	
			$730,549.48
CAPITAL STOCK AUTHORIZED AND ISSUED			
1,000,000 shares of $5.00 each			5,000,000.00
SURPLUS ACCOUNT			
Balance at credit 1st January, 1918 ..		198,413.99	
Add—			
Profit for year ending 31st Dec., 1918, before providing for Interest on Advances and Reserve for Depreciation of Ship Stations, etc.		138,647.98	
		337,061,97	
Less—			
Interest on Advances ..	$25,057.62		
Reserve for Depreciation of Ship Stations, etc. ..	18,216.89		
		43,274.51	
			$293 787.46
			$6,024,336.94

Approved on behalf of the Board, J. N. GREENSHIELDS and THOMAS ROBB, *Directors*.

We have examined and audited the Books and Accounts of the Marconi Wireless Telegraph Company of Canada, Limited, for the year ending 31st December, 1918. The Apparatus and Stores on hand have been entered at book value. No provision for depreciation has been made against the High Power Stations Equipment, which is carried in the accounts at cost.

Subject to the foregoing remarks, and to the reserve for doubtful accounts being sufficient, we certify that we have obtained all the information and explanations which we have required, and that, in our opinion, the above Balance Sheet as at 31st December, 1918 is properly drawn up so as to exhibit a true and correct view of the state of the Company's affairs according to the best of our information and the explanations given to us, and as shown by the books of the Company.

Montreal, 1st May, 1919.

RIDDELL, STEAD, GRAHAM & HUTCHISON, *Chartered Accountants*.

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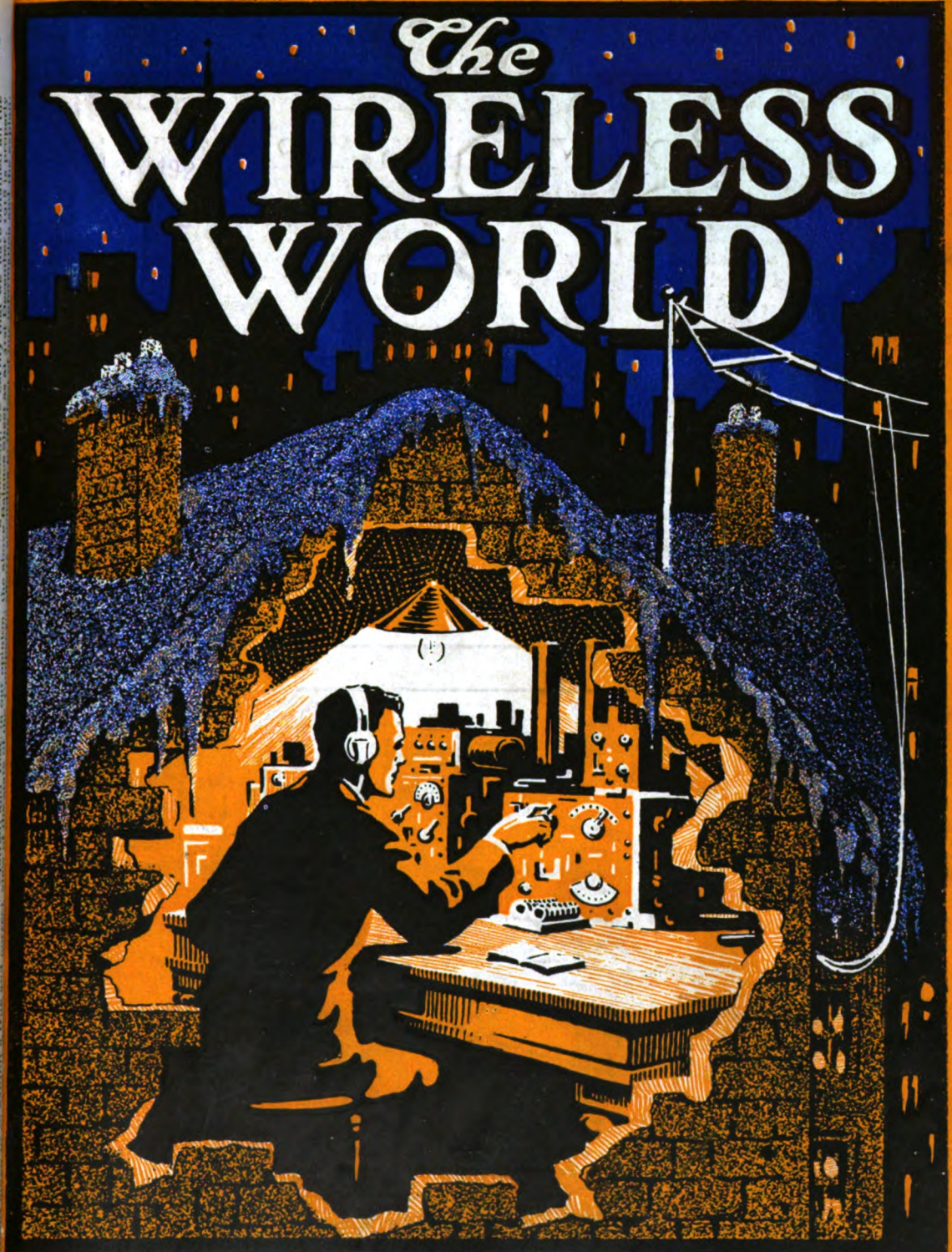
Price 9d. Net. DECEMBER, 1919.

The WIRELESS WORLD



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TRIODE VALVE GENERATORS for A.C. bridge testing.

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THE
WIRELESS WORLD

No. 81
Vol. VII

DECEMBER,
1919

The Kamina Wireless Station

ITS CONSTRUCTION AND DESTRUCTION

AMONGST the numerous events of the Great War which have almost escaped public notice the Togoland campaign is particularly interesting as it was in the Kamina Wireless Station that the surrender of the Colony was effected.

Lome, the Government town, situated on the seashore and quite close to the British frontier, was occupied by British troops in the first days of the war, whilst the French troops were advancing westwards on the littoral. As a result of these operations the German Colonial Government, as well as German troops and business people were obliged to retire towards the hinterland to the Kamina high power wireless station. Here they installed themselves, resolved to defend it energetically, and started digging trenches.

The British and French columns on this side were each closing in upon them. The British were following the railroad line to Atakpame, the bridges of which the Germans had blown up, whilst the French were advancing by an unfinished road, which starting at Anecho, was intended when finished to meet the railroad at about half way from Atakpame. It was a little further on, near the village of Chra, that the Franco-British vanguards came into contact with the German rear-guards, and after a short fight the latter were forced to fall back on Kamina. Von Doering, Acting Governor of Togo, judging then that resistance would be impossible, decided to surrender after having destroyed the wireless station.

For this purpose the Germans placed two large drums of petrol in a room where they had prepared several wood fires. They then went outside and fired at the barrels from a distance, flooding the whole place with petrol and immediately setting on fire the whole building. During that time other parties of Germans were destroying the aerials and lattice masts. There were ten masts having the shape of a prism, each resting

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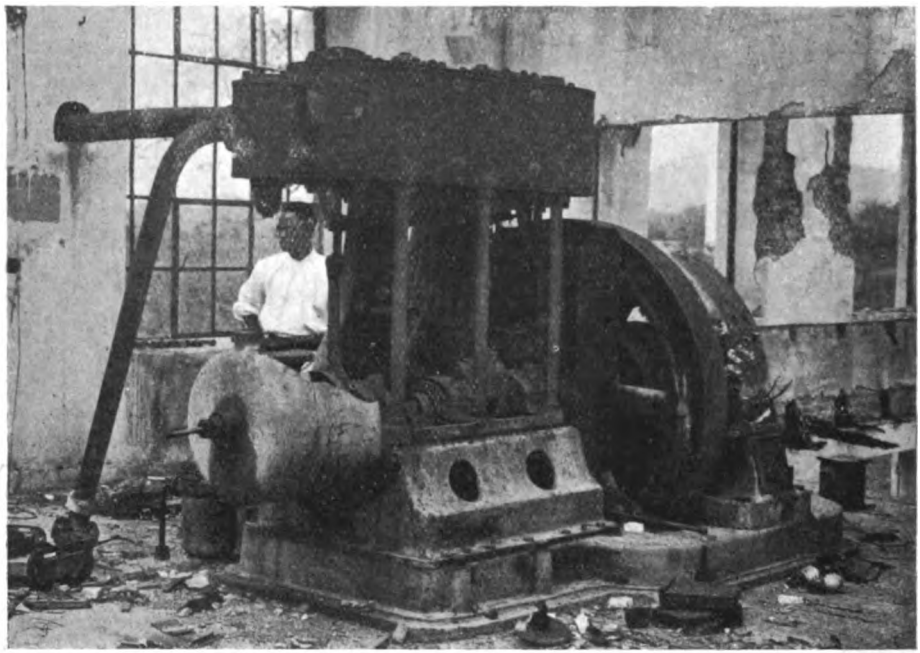

A good example of how the Germans destroyed with hammers what had escaped the fire.

Franco-British occupation of Kamina Station. The main switchboard after its "morning hate."

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on a point on a cast steel base insulated by lenticular glass insulators. These masts being held in a vertical position by means of stays, it was sufficient to unscrew the stays from their anchorage on one side of the mast in order to bring down the whole mast with a crash to the ground on the opposite side.

When, therefore, the British and French troops arrived at Kamina nothing remained of that powerful wireless station but smouldering ruins, upon which the Germans still vented their fury by breaking up with sledge hammers whatever had been spared by the flames.

The photographs which we are so fortunate as to be able to reproduce show very well this side of the Teuton's thoroughness. Such utter destruction of good machinery as to its smallest parts must be inexplicable to true engineers, who would content themselves by doing some vital damage sufficient to render the station beyond repair, and would not smash the unessentials. On looking at these pictures one is tempted to think of our late enemies as naughty, screaming children breaking their toys.

The Kamina station had an effective power of 250 kw. It was really 325 kw. if we add the supplementary 75 kw. of D.C. which were necessary for the general service of the station, such as accumulators, light, blowers, water pumps, servo motors, workshop gear, etc.

The transmitting system already installed was of the normal Telefunken type with sparks divided and blown

The German staff at Kamina. The kultured part of it forms the top row

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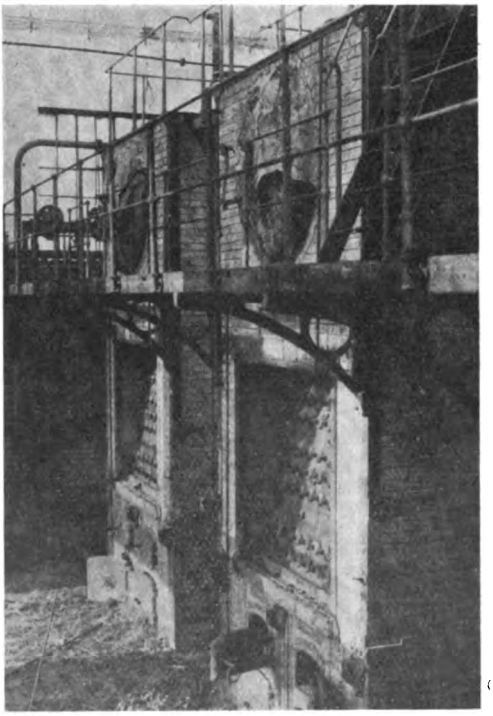
off by means of powerful blowers, the object of which was also to cool the multiple plates of the spark discharger. The necessary alternating current was supplied by a group of Curtiss—A.E.G. turbo-alternators of 250 kw. The continuous current was produced by a group consisting of dynamo and steam engine of the vertical marine type coupled on the same shaft. *Every machine was duplicated.*

The transmitting aerial was of the flat top type made of twenty wires, ten each side with a wide free space in the middle, and was supported by four lattice masts, each 120 metres in height. Each wire was straightened by extension wires fixed at the top of twenty small masts and could be kept always at the same tension by means of counter-weights. The receiving aerial consisted of a single big bronze cable about 3,800 metres in length supported by five masts of 120 metres, and three 75-metre masts; the construction of two more 75-metre masts was planned, and their foundations already started upon.



Another view of the gutted station.

The Kamina wireless station was supposed to work as a relay station between Nauen and the Windhuk station, in German West Africa and also Dar es Salaam in German East Africa. In the meantime Kamina was a connection between the Metropolis and the German colonies of Togo and the Cameroons, possessing respectively the two 25 kw. wireless stations of Togblekhove and Duala. The latter was completely destroyed by the Germans, but at Togblekhove station they only had time to destroy the lattice mast and to take away the receiving set and the spark discharger.

The building of the Kamina station was started in 1912 under the supervision of Baron Codelli, and it was fitted with the latest improvements.

The construction was not quite finished in August, 1914, and the war began during the first trials between Kamina and Windhuk and Dar es Salaam.

This station presents an example of the better side of German colonial methods, although there is no doubt but that it was primarily intended as a mere outpost of the Wilhelmstrasse. Yet one is struck by the enormous pains which were taken over the technical details, and the lavish outpouring of money. It would be interesting to know how many other high-power wireless stations in the colonies or remote footholds of other countries are provided with a complete duplication of plant.

The accompanying photograph of the

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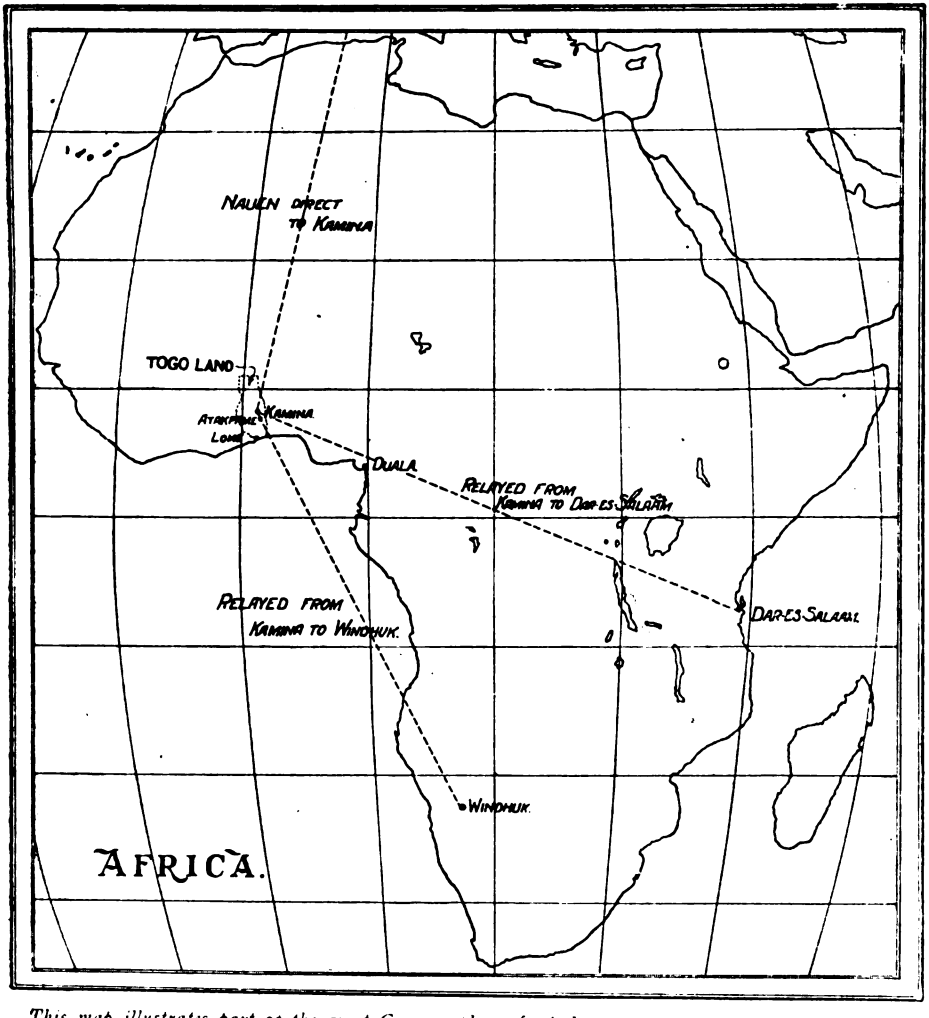

This map illustrates part of the great German plan of wireless "penetration." This particular strategic system worked very well till the relay station was captured.

German wireless staff is unique. Our contributor who supplied it and the interesting notes detailed above, states that but one print was obtained from the negative when the latter was destroyed by a native in German pay. It furnishes a curious sidelight on the German temperament, because anyone with experience of even larger stations than Kamina knows that nothing like such a large unskilled staff would be required, and the precise object in putting so much "coloured" padding into the group is difficult to divine. Probably there was some intricate piece of propaganda at the back of the idea.

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MR. A. A. CAMPBELL SWINTON, F.R.S.

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Personalities in the Wireless World

MR. A. A. CAMPBELL SWINTON, F.R.S., was born in Scotland in 1863, and at the age of nineteen was apprenticed to Lord (then Sir William) Armstrong and began his engineering career in the Elswick Works at Newcastle. In 1887 he came to London, where, since then, he has practised as a consulting engineer.

Like so many other eminent men, Mr. Campbell Swinton's activities and interests extend far beyond the immediate claims of his own business. Besides being a member of the Institutions of Electrical, Mechanical, and Civil Engineers, he is Chairman of the Council and Vice-President of the Royal Society of Arts, a member of the Executive Committee of the British Science Guild, and from 1912 to 1915 was a Manager of the Royal Institution of Great Britain. He is a Past-President of the Röntgen Society, and in connection with this it is of interest to note that he took the first X-ray photographs ever produced in this country. These photographs hang in his office in Victoria Street in company with others which illustrate the radiographic art as applied to the hands of various celebrities.

He is a devotee of photography, having engaged in it since the age of ten years That he is also a master of it is evident from the portrait—taken by himself—which is reproduced on the opposite page.

At the present time, when hundreds of our readers are so deeply interested in amateur wireless work, the subject of our biographical notes retains for us a special interest because he is the President of the Wireless Society of London. Mr. Campbell Swinton has for a long time been an enthusiastic private experimenter in wireless, and it is quite certain that the subject lies near to his heart—for he makes his own apparatus; an example of his workmanship is shown on another page of this number. Now that the Wireless Society has resumed its work we feel sure that under the wise Presidency of Mr. Campbell Swinton it will, through its able Committee, accomplish a most useful work for science and for the fraternity of amateur wireless men.

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Stray Waves

The Amateur Position.

ALTHOUGH no public announcement has been made by the authorities regarding the granting of licences for wireless transmission by amateurs, we understand that the Post Office is now prepared to consider applications for informal permission to do such work. It need scarcely be said that at the present stage of Dora's lingering demise these applications will be dealt with fairly severely and the needful permission only given in cases where the applicant is considered to be highly-skilled in the use of his apparatus and is desirous of prosecuting serious experimental work not likely to interfere with commercial or official stations. (See p. 535.)

So far as reception is concerned, little difficulty should be met by any amateur in securing permission to work, and this aspect of the situation may thus be considered to be cleared up, though we would respectfully urge the Post Office to be more generous with regard to the dimensions of the amateur's aerial. If a person intends to use crystals, then we can think of no reason why he should not be allowed to erect as large an aerial as he likes.

* * *

RADIOGONIOMETER AND TRIANGULAR DIRECTIVE AERIAL PATENTS.

There has been an action brought by Professor Artom against Mr. Bellini and others before the County Court, Court of Appeal, and Court of Cassation of Turin on the ground that the invention forming the object of Artom's Italian Patent No. 88,766, and other corresponding foreign patents in his or other's name, commonly known under the name "Radiogoniometer," or "Direction Finder," had been in some publications attributed to Bellini and Tosi, and the invention protected by the Italian patent 88,765, and corresponding foreign patents in Artom's or other's name, commonly known under the name of "Dirigible Triangular Aerials" had been attributed to other persons.

The Court of Appeal of Turin by the judgment dated July 18-24th, 1914, confirmed by the Court of Cassation on June 26th, 1915, decided that said publications were an infringement of Prof. Artom's rights, as it could not be contested, even in print, that said inventions belonged to Prof. Artom's intellectual patrimony, this having been admitted by Mr. Bellini himself in his declaration before Mr. Rolando, Public Notary, dated April 5th, 1912, whereby he bound himself to withhold from any opposition.

* * *

LORD FISHER ON WIRELESS.

We take the following extract from Lord Fisher's interesting "Memories," published in *The Times* of October 17th:— . . . . . "An intercepted German naval letter at the time gave me personally great delight, for it truly divined that wireless was the weapon of the strong Navy. For the development of the wireless has been such that now you can get the direction of one who speaks and go for him; so the German daren't open his mouth. But

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if he does, of course, the message is in cipher; and it's the elucidation of that cipher which is one of the crowning glories of the Admiralty work in the late war. In my time they never failed once in that elucidation."

* * *

THE HYDROCARBON IN ARC CHAMBERS.

From an extremely interesting article entitled "Development of Arc Radio Transmitters," contributed by Messrs. A. L. Anderson and H. F. Elliott to the *Electrical World* (August 30th, 1919), we extract the following:—"The magnetic field strength is a function of the power, frequency, and kind of hydrocarbon used." "Alcohol is the hydrocarbon generally used with the smaller arcs. Kerosene is used where considerable power is required on short wavelengths. It will increase the antenna current when the magnet field is weak, but produces soot in the chamber, which makes an occasional cleaning necessary. Illuminating gas is used when available."

Speaking Across the Atlantic by Wireless Telephony

A Report of the Public Lecture Delivered by Professor J. A. Fleming, M.A., D.Sc., F.R.S., on Wednesday, October 22nd, at University College, Gower Street.

THE lecturer opened his entertaining discourse with a brief description of wave motion in general and in particular of the mechanism of sound transmission through air. He pointed out that different sounds have different wave characteristics, and described an instrument that had been developed in the Research Laboratories at University College in the course of certain experiments made during the war, for the purpose of delineating the wave form of various types of sound. This instrument he termed a "Phonoscope" or "Phonodeik." The general construction of this apparatus was shown by means of lantern slides. By its use it is possible to delineate on a photographic strip the wave form of various speech sounds. A number of lantern slides were shown illustrating the different types of vowel sounds. The lecturer showed by the addition of a number of curves of different wave-lengths the manner in which a complex shaped wave form is built up of a number of sine wave harmonics, and explained the reverse process, known as Fourier's analysis, by means of which a complex wave form may be analysed into its constituent harmonics. A number of films were on view showing the wave form of various speeches—such as Hamlet's "To be, or not to be," etc.

To further the explanation of Radio-

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telephony the elements of simple line telephone apparatus were described by the aid of lantern slides. Sections were shown of the transmitting and receiving instruments and diagrams of their mode of connection together. The great disadvantage of wire telephony, as compared with radiotelephony, is the distortion that occurs with the former when speaking over long distances. More particularly is this distortion felt when speaking through cables. A diagram was shown of the wave form of the "oo" sound such as in "moon," at the beginning and at the end of a long cable. All the irregularities in the original sound were smoothed out by the action of the cable, so that the resultant wave form at the receiving end was practically only a smooth sound curve. This means that all the vocal character of that sound would be lost at the receiver, and it would be impossible to distinguish what word had been spoken.

The action of the cable in producing this distortion takes the effect of damping out all the higher harmonics in the wave form. The lecturer compared this action to that of a race in which both men and boys take part. The energetic boys rush forward at the beginning but are soon worn out, whereas the men would sustain their pace throughout the whole race.

The general principles of radio transmission were explained at length by the help of slides and the essential need for high frequency oscillations in the transmitting aerial was pointed out. There are three chief sources of such oscillations of the type required for radiotelephony: High Frequency Alternators, Poulsen Arcs, and Vacuum Valves. The principle by which an alternator may be constructed to set up high frequency currents was explained by diagrams and also by photographs of parts of Alexanderson's High Frequency Alternators. These machines although suitable for use in fairly large units are far too costly for small experimental work.

The Duddell Oscillating Arc was next dealt with and the mechanism by which its falling characteristic is used to set up oscillations in a shunt condenser circuit was lucidly explained.

A few brief remarks about the constitution of atoms and electrons preceded a description of the Fleming Oscillation Valve. It was pointed out that all hot bodies, lamp filaments, a hot poker, the sun, etc., are all emitting torrents of electrons from their surfaces. This electron emission is ordinarily hindered by the pressure of the surrounding air, the molecules of which are, comparatively speaking, crowded together round the surface of the hot body, but in a vacuum such thermionic emission, as it is called, can take place quite freely. Since these electrons are negatively charged they are attracted by a positive charge. This phenomenon was made use of by Dr. Fleming in 1904 in his application of the Edison effect to the construction of his oscillation valve. Such a valve in its simple form is only available for use as a rectifying detector, but it was subsequently modified by De Forest in America into what is now known as the Three-Electrode Valve, so called because it has three essential component parts, the hot filament, the anode or plate electrode, and a grid between these two. The action of the grid in bringing about the amplification of a small potential applied to it was explained and various circuit arrangements of the three-electrode valves used as detectors were shown. One of the well-known French valves and a larger transmitting valve were on view after the lecture.

The great importance of the Three-Electrode Valve, as compared with the Two-Electrode, or Fleming Valve, is

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that a number of such valves can be connected up in cascade, that is to say, the received impulse can be amplified by the first valve, the resultant amplified current used to affect a second valve through a transformer and so on. A Marconi Seven-Valve Amplifier with the valves connected in cascade in this manner was shown.

In addition to acting as a detector, the Three-Electrode Valve may be employed to set up high-frequency oscillations. An analogy was given of the singing telephone and microphone placed near to each other and connected together to explain the means by which the valve can sustain oscillations in a closed circuit. These valves may in this manner be used for transmission purposes, but it is necessary to have a high voltage battery to supply the energy to the plate circuit of the valve. In practical working a small alternator is frequently used to supply this voltage, and the resultant high voltage is rectified by one or more Fleming Valves before being used with the main oscillation valves. The circuit diagram of the arrangements used by the Marconi Company for this purpose was shown, as well as the means by which the local transmitting microphone may be used to modulate these oscillations in accordance with the speech to be transmitted.

Valves of this type were used in recent experiments in radiotelephony across the Atlantic. These tests were carried out from the Ballybunion Station of the Marconi Company with the object of determining the minimum power required for practical day-time working. They were, therefore, not merely a costly experimental feat like the Arlington to Eiffel Tower Radio Telephony tests in 1915. Particulars of the Ballybunion experiments were quoted by the Lecturer from a recent article in the WIRELESS WORLD.

Radiotelephony is now also available for use in aircraft and in fact it is being regularly so used on the London-Paris Air Service. The machines engaged in this service are not out of radiotelephone touch with English, or French, Stations during the whole of the journey. The apparatus may also be used for speaking between aeroplanes, as well as from aeroplanes to the ground.

At the present time it is not absolutely essential that large elevated aerials should be employed, as it is now possible to use only a few turns of wire wound on a small frame in order to receive radiotelephone messages over considerable distances. For this purpose one of the multi-valve amplifiers, such as the instrument that was on view are necessary to amplify up the received signals. Such a loop transmits best in its own plane, and very little energy is radiated in a plane at right angles. Conversely such a loop will receive best from a station in its own plane. Loop aerials of this type may, therefore, be used for direction-finding purposes, such as for locating a distant aeroplane. During the war loop aerials of this type were used by our airmen for locating Zeppelins. Once a Zeppelin made use of its wireless its position could very quickly be determined by our men, who were then able to interview it.

Dr. Fleming confidently looked forward to a regular Trans-Atlantic Radiotelephone Service in the near future, when it would be as easy to speak from London to New York as at present it is to speak to Glasgow, or Edinburgh, with the additional advantage that with the Radiotelephone there is no distortion and the received speech is remarkably clear, since all waves travel at the same speed through the æther.

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Digest of Wireless Literature

ON THE PROPAGATION OF ELECTROMAGNETIC WAVES ROUND THE EARTH.

By Balth van der Pol, Jun., D.Sc. (Utrecht).

Philosophical Magazine, Vol 38, p. 365, Sept. 1919.

The theoretical problem of the bending, by diffraction, of electromagnetic waves round the earth has been attacked by various writers. This work is largely mathematical and for convenience of calculation the earth is imagined to be a conducting sphere, the circumference of which is large compared with the wave-length of the radiation, and the atmosphere surrounding the earth is regarded as a perfect insulator. However, when the amplitudes of the waves received at various stations from a fixed sending station are compared with the calculated values obtained from the mathematical solution, discrepancies are found. It is thus obvious that effects other than those of pure diffraction must be taken into account. That signals from a distant station are as a rule stronger during the night than during the day, undoubtedly indicates that the electrical conditions of the atmosphere have a pronounced influence on the wave amplitude. An annual variation of signal strength in overland transmission has further been found: also the intensities of the signals received during the night show further appreciable fluctuations while the day-time intensities are usually more steady. This last fact suggests that the day-time values of received wave-amplitudes may be regarded as "normal." The object of this paper is to compare these observed "normal" values with the magnitudes to be expected according to the diffraction theory.

Solutions of the mathematical problem suggested above have been obtained by Nicholson, Macdonald, Love, and Watson. All these solutions at first sight appear different, but more detailed examination shows that they are in close agreement within the limits of their validity. The investigations of Macdonald, Love, and Watson show that a finite conductivity of the order of $\sigma = 10^{-11}$ such as sea water actually possesses, has only a small influence on the wave amplitude increasing it a few per cent. in comparison with the case of infinite conductivity. The same result is found by Watson allowing for the conductivity of the earth. Therefore where discrepancies arise between experimental values of wave amplitude and theoretical formulæ the cause is not to be sought in the finite conductivity of the earth's crust.

If we consider the case of a simple Hertzian oscillating doublet and confine our attention to intensities along a great circle of the conducting sphere the formula giving the ratio of the received antenna current I_R to the sending antenna current I_S for the assumption of a perfectly insulating atmosphere and a perfectly conducting earth is as follows.

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$$\frac{I_R}{I_S} = 0{\cdot}5368 \cdot \frac{I}{\sqrt{\sin\theta}} \cdot \frac{a_1 h_1 \times a_2 h_2}{\lambda^{7/6} R_2} \cdot e^{-\,0{\cdot}00376\, d/\lambda^{1/3}}$$

where R_2 is the total equivalent resistance of the receiving antenna in ohms,
h_1, the actual height of the transmitting station,
h_2, the actual height of the receiving station,
α_1, the form factor of the sending station,
α_2, the form factor of the receiving station,
d, the distance in kilometres between the two stations,
λ, the wave length in kilometres, and
θ, the angular distance between the stations measured in radians.

The quantity α has been defined by Zenneck as the ratio of the mean current amplitude divided by the product of the antenna height and the maximum current which is usually found at the bottom of a transmitting aerial. A comparison of the above formula with experimental observations must now decide whether actual wireless communication is established by diffraction alone, the atmosphere being regarded as a perfect insulator.

Experimental data on this subject are very few in number. Practically all the work has been carried out by Austin, who measured the signals in a telephone receiver by shunting the latter down to such an extent that dots and dashes could just be discriminated, the value of the shunt giving an indication of the amplitude of the waves at the receiving station. Now the numerical relations entering into the action of crystal and thermionic detectors are not yet completely known and no definite quantitative theory of their action has been advanced. What was therefore actually determined in Austin's experiments is the strength of the sound in the telephone receiver representing a quantity of energy which was initially drawn from the energy of the incident radiation. Unfortunately Austin is not very clear in the description of his experiments and it is difficult to decide whether certain values or constants were obtained experimentally by him or were calculated or estimated. The smallest amount of energy in the receiving antenna producing a barely audible sound is given by Austin as $1{\cdot}225 \times 10^{-15}$ watt.

It is obvious that the measurement of these amazingly small alternating energies is a matter of considerable difficulty and that variations in the observations of a few hundred per cent. are to be regarded as relatively small, especially in view of the atmospheric disturbances which occasionally prevent the observations altogether. When the value given above is accepted as the limit of measurable energy an estimation of the oscillating electric field near the receiver antenna can be made on the basis of a total antenna resistance of about 25 ohms and an effective receiving antenna height of 146 metres which are the figures given for the receiving system at Darien where a part of Austin's measurements were carried out.

From this it can be calculated that the least amplitude of alternating potential gradient measurable in this way is of the order of 10^{-11} per cm., being about 10^{-11} of the normal static atmospheric potential gradient; and it is therefore not surprising that proportionally small variations in the latter field (in the form of strays or atmospherics) occasionally prevent or disturb the measurements of the minute

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alternating field superimposed upon it. If we accept Austin's observations as giving the true antenuation of wave amplitude with distance, it is at once evident that the pure diffraction theory cannot explain the experimental data.

As a single instance we may take the measurements at Darien of the waves sent out by the Nauen station. In this case Austin gives,

$I = 150$ amp. $\lambda = 9{\cdot}4$ kilometres $\alpha_1 h_1 = 120$ metres
$\alpha_2 h_2 = 146$ metres $R_2 = 29$ ohms $d = 9{,}400$ kilometres.

This is the largest distance up to the present over which received antenna currents have been measured. The audibility factor in this case was 200 corresponding to a received antenna current of $I_R = 1{\cdot}3 \times 10^{-6}$ amperes, while the theoretical diffraction formula above would yield $I_R = 6 \times 10^{-13}$ amperes. In this case therefore the actual value of the wave amplitude according to Austin's measurements is about two million times bigger than the calculated value. Even if we allow for experimental errors of a few hundred per cent. the disagreement is still enormous.

As several theoretical investigations have undoubtedly proved that the finite conductivity of the earth's crust cannot increase the wave amplitude to such an enormous extent and as the conductivity of sea water is the same for high and low frequencies, the cause of the discrepancy cannot be due to the earth. It must be due to the atmospheric conditions.

It is almost certain that a good deal of the action can be explained by the theory of ionic refraction due to Dr. Eccles who suggested a possible increase of phase velocity of long electromagnetic waves when propagated through an ionized gas which would cause the wave-front to follow more or less the earth's curvature.

Recently Professor Watson has investigated the case, assuming that in the upper atmosphere there is a spherical shell of finite conductivity, concentric with, and surrounding, the earth. With the assumption of a sharp inner boundary of this shell and for a certain conductivity of the latter, values of the field can be obtained of the order of magnitude of the experimental observations. But it is doubtful whether this sharp inner boundary actually exists in Nature.

THE MEASUREMENT OF ALTERNATING WAVES WITH THE BRAUN TUBE.

By E. Lubke.

Electrician, Vol. 83, p. 270. September, 1919.

This paper, which also appeared in the *Jahrbuch der Drahtlosen Telegraphie*, describes a novel application of the Braun Cathode-ray tube to the delineation of alternating current waves. Instead of the usual method in which the curve of the waveform is directly delineated upon the fluorescent screen of the tube, the cathode-ray beam is employed to ionise the space between the plates of a small condenser mounted on the end of the usual tube. The beam is caused to rotate in a conical path, by electromagnetic deflection, so that the instant of ionisation with respect to the position in the cycle can be controlled at will by rotating the deflecting coils around the tube. The condenser plates take the place of the contact-maker in the delineation of the waveform by the "Joubert" contact, point-by-point method. Examples of curves are given in the paper. A modified method is also described, and is suitable for frequencies up to several million per second.

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Notes on the Design and Construction of Valve Amplifiers

By John Scott-Taggart. M.S Belge E., A.M.I.Radio E.

II.—DETECTOR-AMPLIFIERS

A VERY useful 4-valve amplifier suitable for general use on a modern wireless station is represented by Fig. 7. It possesses the usual features, but, of course, is more sensitive than the previous examples. Each valve is capable of a magnification of about 5 times, and so with such an amplifier signals would be increased at least 600 times their normal strength.

With regard to the mounting of these circuits on a base board, care should be taken to insulate all parts very carefully, and to keep the different connecting wires and transformers away from each other. In early experiments with amplifiers considerable difficulty was experienced on account of induction and capacity effects between the different component parts. It will also be convenient to provide two "in-put" terminals Y and Z, two terminals to which the four-volt filament-heating accumulator may be connected, and two for use with an external plate battery.

In the preceding notes we considered the simple low-frequency amplifier. Such an instrument is the most useful for ordinary work. There are cases, however, where a complete detector-amplifier is desirable. Such an amplifier may be connected across any oscillatory circuit without the need of a separate rectifying vacuum tube.

Detector-amplifiers may be roughly divided into two classes:—

(1) Arrangements of valves in cascade in which the first valve acts as a detector, the subsequent vacuum tubes acting as low-frequency amplifiers.

(2) Arrangements of valves in cascade in which the first vacuum tubes act as amplifiers of the oscillations and the last one as a detector. This second class is by far the most desirable, but the circuits are usually more difficult to operate and do not function equally well over a wide range of wave-lengths. Neither of these defects are experienced in the first class of detector-amplifiers.

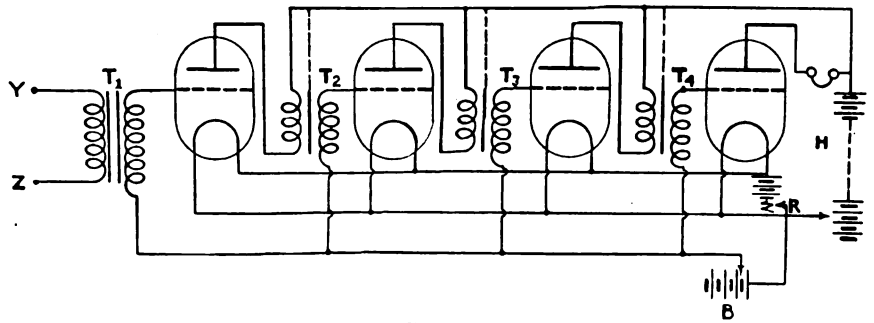

Fig. 7.
A 4-valve Amplifier.

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A simple arrangement is shown in Fig. 8 which shows a typical 4-stage receiver. The input terminals Y, Z of the detector-amplifier are shown connected across the closed oscillatory circuit L_2 C_2 as an example of the use of such an amplifier. The first valve rectifies on the cumulative leaky grid condenser principle, a condenser C_3 of ·0003 mfd. and a resistance R_1 of 3 megohms being provided. A simple resistance may be made by cutting two or three grooves about 2 inches long on a piece of ebonite with the point of a knife, and filling these grooves with graphite by rubbing the point of a pencil across them until the required resistance is obtained. Suitable terminal connections are made at the ends of the grooves.

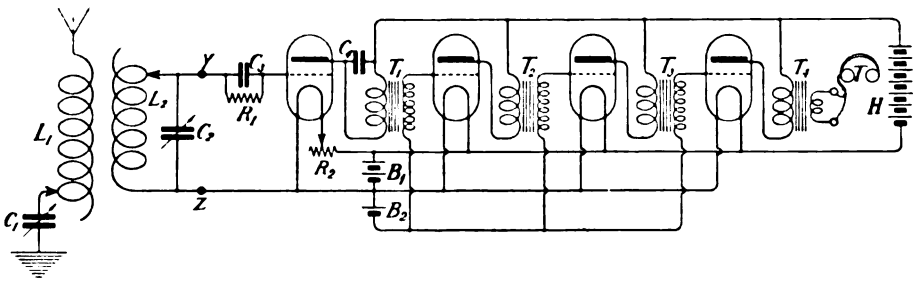

Fig. 8.
A Typical 4-stage Detector-Amplifier.

In order to facilitate the adjustment of the first valve to act as a rectifier, a separate filament current rheostat R_2 of about 5 ohms maximum resistance is provided.

Three intermediary step-up transformers T_1, T_2, and T_3 are arranged in a manner similar to that adopted in the low-frequency amplifiers already described A condenser C_1 is connected as shown in order that the high-frequency component of the plate current of the first valve will be by-passed. The practice of connecting a condenser of about ·0008 mfd. across any impedance in the plate circuit of a rectifying valve is widely adopted. It prevents arcing in the transformer T_1 and also assists in obtaining a certain retroactive effect. It also stores and "flattens out" the rectified current.

A step-down telephone transformer is shown and also a battery B_2 for impressing on the grids of the amplifying tubes a slight negative potential.

Fig. 9 shows a very useful amplifier for general wireless work. It is of the three-stage type largely developed by the French during the war. The special feature is that the arrangement can be used as a low-frequency amplifier or as a detector-amplifier, thus combining two instruments in one. Three terminals, D, L and C are provided. The terminals D and C are used if the amplifier is to be applied directly to an oscillatory circuit. In this case the switch S is moved over to the top stud so that the leaky grid condenser C_1 is brought into use, the input transformer T_1 T_2 being isolated. If the amplifier is to be used for magnifying low-frequency cur-

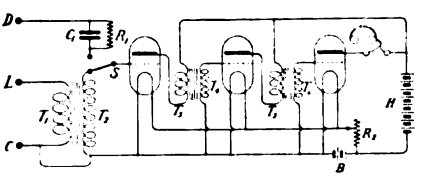

Fig. 9.
Three valves arranged in cascade to act as a Detector-Amplifier or Low-Frequency Amplifier.

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rents such as rectified pulses, the currents are passed through the transformer primary T_1, connection being made to the terminals L and C, and the switch S being moved on to the bottom contact. The values of the transformer windings and other details may be made the same as in the case of other amplifiers described

Coming now to the problem of amplifying our oscillations before rectifying them, we have several methods open to us. We can use inter-valve oscillatory circuits which may be of the tuned or aperiodic variety, and of either the auto-transformer or ordinary air-core transformer type.

latory circuit will possess a certain natural wave-length which should invariably be made smaller than the length of the shortest waves to be received. To prevent the plate battery H giving the grids of the 2nd, 3rd and 4th valves an excessively high positive potential, insulating fixed condensers C_2, C_3 and C_4 are arranged as shown. Although acting as insulators to the steady voltage of H, yet they will allow the high-frequency potential variations at the feet of L_2, L_3 and L_4 to be impressed on the grids of the 2nd, 3rd and 4th valves. The capacity of each of the fixed condensers may be ·0003 mfd. To prevent the excessive accumulation of electrons on the

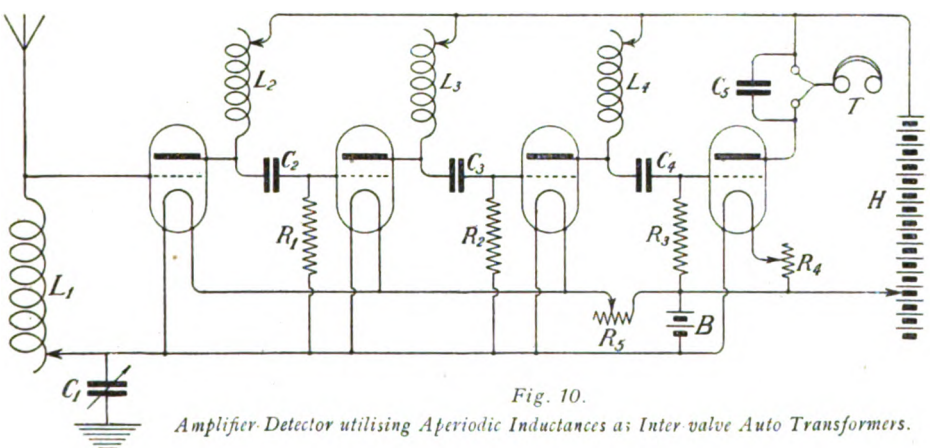

Fig. 10.

Amplifier-Detector utilising Aperiodic Inductances as Inter-valve Auto Transformers.

A 4-valve amplifier detector is reproduced in Fig. 10. The intermediary oscillatory circuits are of the auto-transformer type. Inductances L_2, L_3 and L_4 are arranged in the plate circuits of their respective vacuum tubes and serve to apply the amplified high-frequency E.M.F.'s to the grid or input circuit of the succeeding valve. In the figure the inductances are shown aperiodic. They will consequently respond over a wide range of wave-lengths without requiring anything more than a rough adjustment. It is to be noted that each oscil-

grids of the last three valves, high resistances R_1, R_2 and R_3 are arranged as leaks and may conveniently have a valve of about 4 megohms. It is probable that each valve acts to a certain extent as a cumulative rectifier, although the last valve is intended to rectify the high-frequency current amplified by the preceding valves. To assist in obtaining the best rectifying conditions, a filament current rheostat R_4 is provided.

The amplifier of Fig. 10 may be modified by tuning the intermediate circuits. Variable condensers are then shunted

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across the inductances L_2, L_3 and L_4, each plate oscillatory circuit being tuned to the incoming wave-length. This necessitates a considerable amount of adjustment, which may be lessened by arranging that the condensers are all varied simultaneously.

Another variation consists in having two variable contacts on each of the inductances L_2, L_3 and L_4. For example, the connecting lead from each plate may be taken to a variable tapping on the inductance instead of to the foot of the inductance. By this auto-transformer arrangement, a certain amount of "stepping-up" is obtainable and rather finer tuning is possible.

amplifying tube through the intermediary of the air-core transformer L_2 L_3. Each of these windings is aperiodic and will respond to a wide range of wave-lengths, differing sometimes by as much as 2,000 metres. Each coil will have a natural frequency which can be calculated by a simple formula which is of utmost value to the designer of wireless circuits. This formula is:—

$$\lambda = 2\, f\, l,$$

where

λ = wave-length of coil,
l = length of wire on coil,
f = a factor which is given in the following table drawn up by P. Drude:—

g/d.	6·0	4·0	3·0	2·0	1·0	0·8	0·7	0·3	0·1 = h/2r.
1·09	0·68	0·76	0·84	1·00	1·33	1·47	1·56	2·08	2·79
1·24	0·67	0·75	0·83	0·97	1·27	1·39	1·46	1·91	2·57
2·40	0·66	0·74	0·81	0·96	1·225	1·34	1·41	1·79	2·28

The next type of amplifier which comes under discussion possesses loosely-coupled intermediary circuits. These, if desired, may be aperiodic as shown in Fig. 11, which illustrates a convenient three-stage receiver. The magnified

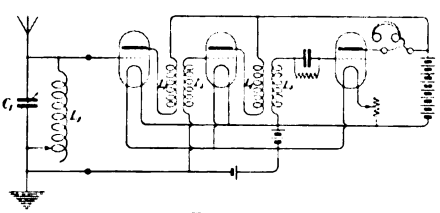

Fig. 11.
A 3-stage Receiver with Inter-valve Aperiodic Oscillation Transformers.

oscillations appearing in the output circuit of the first vacuum tube are passed on to the input grid circuit of the second

The factor f depends slightly on the ratio between the pitch g of the turns and the diameter d of the bare wire used, but chiefly on the ratio between the length h of the coil and its mean diameter $2r$.

The quantities h and l may be found from the formulæ:—

$$h = (m - 1)\, g$$
$$l = 2\pi\, r\, m,$$

where m is the total number of turns and r the radius of the coil.

The wave-length of the aperiodic coils should be less than the lowest wave-length to be received. The two coils of each transformer may be wound directly over each other, although some may prefer to have a variable coupling between primary and secondary.

(To be continued.)

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A Roll of Honour of Italian Mercantile Wireless Operators

IT is unfortunate that the British people are not better informed as to the nature and extent of Italy's efforts and sacrifices during the Great War. We believe that the average Briton has but the vaguest conception of the well-nigh incredible performances of the Italian soldiery in the terrible fighting which took place amongst the mountains of the Italian frontiers. If the reader will acquaint himself with the geographical and geological nature of the country, noting the heights of the peaks upon which King Victor's men planted their country's flag and the frozen inhospitable crags, bristling with long-prepared Austrian batteries against which they unsparingly flung themselves, he will be able to realise somewhat of the stark, stout valour which animates our freedom-loving Allies.

The maritime achievements of the Italians lag behind their military deeds only in extent, not in quality. For Italy it was mainly a land war, yet the Adriatic Sea has been the scene of many a stirring exploit on the part of the Italian Navy. Those dare-devil dashes into the great harbour of Pola alone suffice to stamp our Allies as intrepid sailors, though history bears ample witness as to that. Yet it should not be thought that the Italian is sustained and impelled only by the Latin fire of his blood. He has shown that he knows how to keep a cool head in the face of sudden peril, and to "stick it" to the end. He has written with immortal hand that he can stay at the post of duty and, if need be, die there.

We have hitherto done honour to the memory of those heroic youths, British wireless operators, who bore with their mates of the Mercantile Marine the full

G. Pinto. *L. Saglietto.* *C. Garcia.*

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brunt of the infamous U-boat campaign and died through enemy action, and now that a certain amount of information and some photographs have come into our possession we feel that we can do no less than publish the following details of the sacrifices made by the countrymen of the great inventor who originated their profession.

G Rossi. *V. Cuniberti.* *F. Cuzzani.*

ROLL OF HONOUR.

Names of Operators who lost their lives during the War in the Merchant or Military Transport Service, as a result of their ships being torpedoed:—

Licinio Caso,	S/S. Minas	February, 1917.
Federico Cuzzani,	„ F. Confalonieri	April, 1917.
Vicenso Cuniberti,	„ Catania	April, 1917.
Luigi Saglietto,	„ Catania	April, 1917.
Guido Rossi,	„ Ascaro	May, 1917.
Filippo Welby,	„ Carmen	Dec., 1917.
Carlo Garcia,*	„ Tripoli	March, 1919.

* This operator was posthumously awarded a silver medal for his good behaviour during the sinking of his ship.

Giovanni Bonino,	S/S. Soperga	Sept., 1917.
Giuseppe Pinto,	„ Deipara	May, 1918.
Arrigo Salsa,	„ Gen. Salsa	August, 1918.
Umberto Riggi,	„ Giuseppe G.	Sept., 1918.
Camillo Marcone,	„ Manin	October, 1918.

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ITALIAN ROLL OF HONOUR.

OPERATORS DECORATED FOR GOOD BEHAVIOUR DURING THE SINKING OF THEIR SHIPS.

Luigi Galli,	S/S. Tito Speri	Awarded Italian Crown Cross.
Ugo Coen,	„ Re Umberto	Awarded Bronze Medal.
Carlo Malgaroli,	„ Prometeo	„
Salvatore Longardi,	„ Verona	Awarded War Cross.
Giuseppe Laezza,	„ Vicenza	„

OPERATORS WHO DIED OF INFLUENZA CONTRACTED ON BOARD.

Italo Biotto	S/S. Elba	March, 1918.
Virgilio Jovine	„ Catania	August, 1918.
Ruggero Moro	„ Procida	Nov., 1918.

Pietro Scanarotti, received letter of praise for rescuing passengers from the wreck of S/S. Piero Maroncelli.

Giovanni Jelmini, S/S. Luigi, taken prisoner of war off Gold Coast on March 7th, 1918.

N. Pasqua, awarded Bronze War Cross for courageous conduct during two submarine attacks on his ship.

L. Caso. *F. Welby.* *G. Bonino.*

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Aircraft Wireless Section

Edited by J. J. Honan (late Lieutenant and Instructor, R.A.F.).

These articles are intended primarily to offer, as simply as possible, some useful information to those to whom wireless sets are but auxiliary "gadgets" in a wider sphere of activity. It is hoped, however, that they may also prove of interest to the wireless worker generally, as illustrating types of instruments that have been specially evolved to meet the specific needs of the Aviator.

AIRCRAFT WIRELESS SETS.

SPARK TRANSMITTERS.

THE 54A.

A PHOTOGRAPH of the actual set is shown in Fig. 21, whilst a schematic diagram of the circuits is given in Fig. 22. The characteristic feature is the use of a motor-driven rotary interrupter to replace the make-and-break. When the motor-starting switch S is closed, current from a battery of 28 volts is fed to the brushes B and drives the motor M, at a speed of 3,000 revolutions per minute. A rotary interrupter I of the commutator disc type is mounted on the opposite end of the armature shaft to that carrying the brushes. Altogether there are 12 segments on the interrupter so that in combination with the motor speed of 50 revolutions per second the arrangement gives a "break" frequency of 600. This of course will be the pitch of the telephone note heard at the receiving end.

With the motor running, i.e., the circuit S,O,T,B,M, Battery closed, the ammeter A should give a reading of 1 amp. On load, with the transmitting key K depressed, the reading should be 7.5 amps and 1.5 in the hot-wire ammeter.

ACTION OF THE SET.

This is best seen from the skeleton diagram, Fig. 23, which includes the interrupter, but not the motor circuit. When the transmitting key K is closed, current flows through the coil QR in the direction of the full-line arrow, and, in addition, the condenser C is charged to the full Battery potential.

The Interrupter *break* then occurs, and the condenser discharges through the series inductances RQ, QP, P′P″ setting the closed circuit into oscillation. The natural frequency of this circuit is designed to synchronize with the frequency of the interrupter.

Consequently the following *make* of the primary circuit occurs when the return current surge in the closed circuit is in the direction shown by the dotted-line arrow. As the interrupter circuit is then closed, the discharge surge passes through the Battery which offers a path of less impedance than the coil QR.

This discharge supplements the normal output of the battery and causes a very heavy momentary current surge in the circuit comprising the Battery, C, and inductances P′P″, PQ. A correspondingly high value of e.m.f. is

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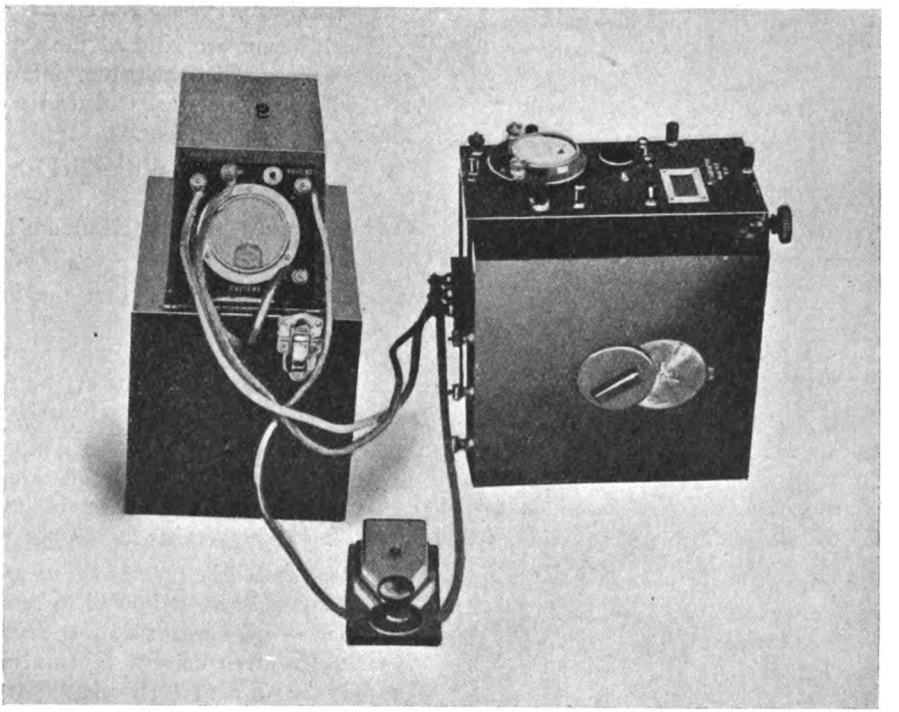

Fig. 21.

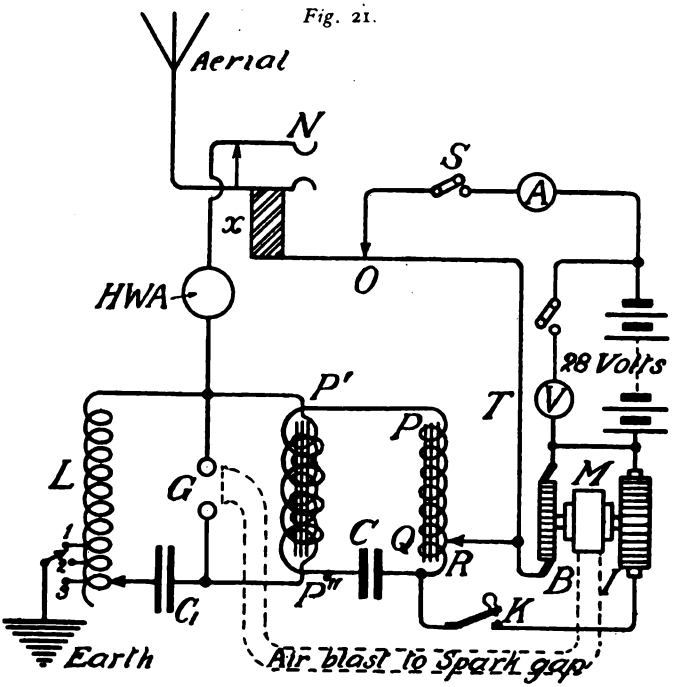

Fig. 22.

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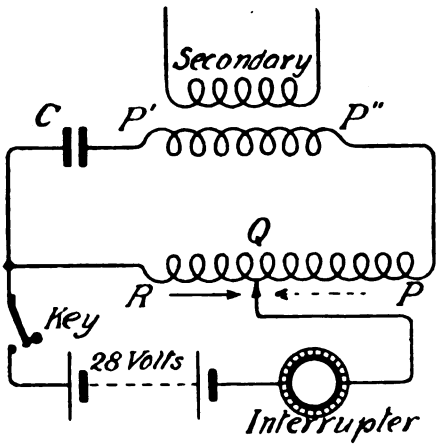

Fig. 23.

thereby induced across the secondary of the transformer.

Simultaneously, current is again being built up in the coil QR, and when the ensuing break occurs the whole cycle is repeated.

The high efficiency of the set is due to the boosting effect of the oscillatory surge upon the Battery current, owing to the synchronism of the closed circuit frequency with that of the rotary interrupter, combined with the shortening of the time period during this part of the cycle caused by the momentary cutting-out of the coil QR.

The voltage across the secondary of the step-up transformer reaches a value of 15,000—20,000 volts which when applied to the condenser C_1, Fig. 22, is sufficient to break down the spark-gap G and energise the closed oscillatory circuit C_1 G, L, which is auto-coupled to the aerial or open circuit.

The spark-gap distance should be between 4 and 5 millimetres. The gap may be ventilated by means of an air blast, created by a rotary "scoop" on the motor and conveyed by a $\frac{1}{4}$-inch tube, as shown in dotted lines.

MOTOR INTERRUPTER.

The efficient working of the set depends largely upon the motor interrupter, which requires careful treatment, and accurate adjustment.

The bearings are plain, and should be lubricated with thin oil. The contact disc must be kept clean and free from grease.

It is most important that the interrupter brushes should be securely bedded on the contact disc. The angle between the brush and the tangent at the point of contact should be approximately 30°.

In fitting the set in the bus, care should be taken to see that it is easily accessible, as it may be necessary to adjust the brushes whilst in the air.

There should be practically no sparking at the brushes. It is well to remember that a high current reading does not necessarily mean correct adjustment, as it may be due to "shorting" at the brushes.

OTHER DETAILS.

A socket N is provided to enable the aerial to be connected to a receiving set. When the plug of the receiver is inserted, an insulating block X automatically stops the motor by breaking the circuit at O.

The weight of the transmitter is $17\frac{1}{2}$ lbs., and that of the rotary interrupter 8 lbs. The battery is contained in a box, both together weighing about 22 lbs.

The range is upwards of 50 miles with efficient crystal reception. The capacity of the battery is sufficient to run the transmitter under constant signalling for about one hour.

The set is designed to transmit at 200-335 and 500-600 metres and tappings marked 1, 2, 3, are taken from the inductance L and give the correct couplings for these values.

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Aviation Notes

OUR BIGGEST AIRSHIP BOUGHT BY THE AMERICANS.

IT has been decided that our latest and biggest rigid-type airship—the R.38—is to be handed over to the United States Navy as soon as she has been completed by Messrs. Vickers. The finishing stages are being accelerated, and before long she will be in the hands of her new owners.

The trans-ocean trip home is, however, to be delayed until such time as suitable accommodation for housing the vessel is ready on the other side.

She is to be handed over to the American crew here, and they will have the task of navigating her across the Atlantic. The R.A.F. have undertaken to train the new personnel free of charge, except pay and rations.

The ship is to be sold at cost price, which is understood to be half a million sterling. It appears to be a somewhat one-sided bargain, to say nothing of the natural regret with which one is bound to regard the loss of so striking a symbol of our national prestige in the new dominion of the air.

But whilst so fierce a gale of economy is raging, there seems to be no alternative but to bend our backs to the breeze with what complacency we can muster.

* * *

PRIZE MONEY FOR AVIATORS.

Although the opportunities for making money in a steady way of business by flying are somewhat restricted at present, there is no lack of inducement offered to the individual pioneer pilot or designer. In addition to the many big money prizes already awarded for various circuit flights and the transatlantic voyage, which will be fresh in the minds of most, the following list shows some of the cash awards still open to competitors.

£64,000 offered by the British Government for the best design of aircraft (aeroplane or seaplane) which combines maximum safety in flight with the advantage of landing and "taking off" in the minimum ground space.

£20,000 offered for the trans-America flight by the Aerial League of America.

£12,000 by the *Echo de Paris* for a 2,500 mile circuit race.

£10,000 to the first Australian pilot who makes the trip from Great Britain to Australia.

£10,000 offered by the *Daily Express* for aeroplane demonstrations establishing aerial communication on a commercial basis with India and South Africa, the machines entered being required to carry at least one ton of cargo.

£10,000 offered by Mr. Thomas H. Ince for a trans-Pacific flight.

£5,000 offered by Raymond Orteig for the first flight from New York to Paris.

In addition a sum of £80,000 has been given by M. H. Deutsch de la Meurthe to the Aero Club of Paris, for the purpose of forming a prize fund for the general development and encouragement of aeronautical achievement. Whilst no less a sum than £360,000 has been earmarked for the same objects by the French Government and is to be spent on Premium Prize competitions between January and July next.

* * *

OUR COMMERCIAL AIRWAYS.

The Blackpool-Southport-Manchester daily flying service was terminated for

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the season at the end of October after a continuous "run" of some five months. The route was opened by the Avro Company towards the end of last May, and has proved a most successful enterprise commercially.

Each day at noon, one or more machines left Blackpool for Manchester, calling at Southport on the way. The total journey took 45 minutes, the machine returning from Manchester at 2 p.m. The price charged was 5 guineas single, and 9 guineas return, but in spite of these high rates in comparison with railway fares, the Aero service more than paid its way. No interruption of the daily trip occurred until towards the end of September, when unusually bad weather led the Company to cancel the flight on several occasions in accordance with their policy of taking no avoidable risk.

The Airco Company completed the first seven weeks of their London-Paris daily service with a record of only three flights less than their scheduled timetable. In one case a fierce hurricane made the Company play for safety; whilst in the second the cause was engine trouble. On the third occasion, the pilot lost his way in a thick fog and made a forced landing in the Channel alongside a passing steamer, who took aboard the pilot, passenger and mails. Unfortunately the plane itself could not be salved, owing to the heavy sea. This seems to be a case where a D.F. wireless installation would have proved a real friend in need.

Up to the end of October the Handley Page Company had transported 219 passengers and over 6,000lbs. of freight between London and Paris.

* * *

DEATH OF THE DESIGNER OF THE "FELIXSTOWE FURY."

Lieut.-Colonel J. C. Porte (late R.A.F.), died last month at his home in Brighton at the early age of 38.

Aviation in general and the flying-boat type of craft in particular owe much to the genius and labours of this gifted designer. He was an Irishman, being born at Brandon, Co. Cork, and secured his pilot's certificate in France as early as 1911 on a Deperdussin monoplane.

The outbreak of war found him in America, but he at once returned home and joined the R.N.A.S. For some time he commanded the depot at Hendon, being subsequently transferred to Felixstowe where his energies were mainly devoted to the completion of the famous but unfortunate "Felixstowe Fury," then probably the largest aircraft in existence. It is a pathetic coincidence that Col. Porte did not long survive the destruction of his mammoth flying-boat.

Photo by Photopress

Late Lieut.-Colonel J. C. Porte.

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The Wireless Society of London

*Report of the General Meeting held in the Lecture Hall of the Institution of Civil Engineers, Westminster, on Tuesday, October 28th**

THE President, Mr. A. A. Campbell Swinton, F.R.S., took the chair at 6 p.m., and the Secretary read the Minutes of the last General Meeting of the Society which was held on December 29th, 1915. These were duly confirmed by the meeting.

THE PRESIDENT then delivered a short address dealing at some length with the resumption of activity of the Society after four years of stagnation during the war. There seemed, he said, every indication of a possibility of the Society resuming useful work among the wireless experimenters of the country. This meeting was to be purely a formal one to confirm the election of the Committee and Executive Officers of the Society. The Committee of the Society that had been elected in 1915 had on their own authority met together with a view to resuscitating the activities of the Society, and this had been done without any authority from the general members, since the rules of the Society stated that the Committee and Officers may only remain in office for one year unless they are re-elected. It had therefore been found necessary to call this meeting, and he would subsequently ask them to pass a resolution confirming the election of the present Committee for the remainder of this year.

The President discoursed upon some of the effects of the war. Its influence had been most felt in aviation and in wireless, both of which experienced considerable development, and it was now felt that the time had come when much useful discussion could take place amongst the members of the Society on some of the latest developments.

The President deplored the loss that the Society had incurred by the deaths of some of its members. In particular he mentioned Sir William Crookes, who had been an Hon. Member, Professor Silvanus P. Thompson and Mr. E. Russell Clarke, who were both Vice-Presidents. Mr. Russell Clarke had been an active member of the Society, and had read them a very interesting paper before the war. He had relinquished his barrister's career to take up wireless work for the Government, and it was largely due to this that he met his early death. In addition to the above, mention was also made of the loss of Mr. William Duddell, well known for his researches on the oscillating arc and for his many inventions of instruments for high frequency measurements, without which a very large number of such measurements could not be made. Sir John Grant had also been one of their esteemed members.

The Committee were at present occupied on the compilation of a list of members who had been engaged in wireless work during the war, and he asked that all members who had any information that might be of use for such a list to communicate it to the Secretary as soon as possible.

Mr. R. H. Klein, who was one of the founders of the Society, and had been its Hon. Secretary, had resigned this

* Readers will be interested to learn that THE WIRELESS WORLD has been appointed the official organ of the Wireless Society of London.

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Mr. R. H. Klein, Vice-President.
(One of the Founders of the Society.)

position owing to pressure of work, and he had been elected by the Committee to be an Acting Vice-President. The Hon. Secretaryship had been taken over by Mr. H. Leslie McMichael, who has resigned his position of Vice-Chairman, which he previously held. Mr. McMichael had been interested in the Society since its inception, and he would be pleased to hear from anyone contemplating membership. The President referred to the honour they had recently received by numbering amongst their Vice-Presidents, Admiral of the Fleet, Sir Henry Jackson, G.C.B., etc., who is taking an active interest in the welfare of the Society and in the work of its Committee. Admiral Jackson, as is well known, was one of the very earliest of experimenters in the science of wireless telegraphy and the Society was fortunate in acquiring his co-operation.

Dr. Knight had been elected to fill the vacancy on the Committee caused by the death of Mr. Russell Clarke.

The Resolution was then put to the meeting that the present Officers and Committee of the Society remain in office for the remainder of 1919.

A MEMBER then proposed an amendment to the effect that the resolution be extended to cover their retention in office for the following year, 1920, as it hardly seemed fitting that after their useful work in keeping the Society alive during the war they should merely remain in office for a matter of two months. This amendment was endorsed by other members present and the above resolution was therefore amended to read that the present Officers and Committee remain in office for the remainder of 1919 and for the year 1920. This was carried unanimously by the meeting.

Mr. F. HOPE-JONES (the Chairman of the Society), then read a list of names of members whose addresses had been lost during the war, and asked members who were present who had not received

Mr. F. Hope-Jones
(Chairman.)

notices, to communicate with him in order that the list of membership might be completed.

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Photo by Lafayette.

Mr. H. L. McMichael
(Hon. Sec.)

THE PRESIDENT then spoke relative to the arrangements in hand with the Post Office regarding licences for wireless experimental work. The Committee of the Society had been in communication with the Post Office on this matter, and he read the last letter, dated August 30th, received from the Secretary of the Post Office. This letter stated that the Postmaster-General authorised the Advisory Committee of the Wireless Society to recommend suitable applicants for transmitting licences when the latter are being issued. At the present time temporary permissions were being granted for receiving purposes. It was stated that very few obstacles were being put in the way of the granting of such permissions, provided that the applicants were able to assure the Post Office that they were of British nationality and were capable of utilising the gear in a proper manner. Permissions for the use of valves for reception purposes were also being given to those who could show that they were able to operate them in a proper manner. Applications for transmitting licences were at present only being considered for commercial purposes and for very special cases of definite scientific research. The President added that the Society had written again to the Post Office with a view to expediting the granting of such licences, but that up to the present no further reply had been received.

THE PRESIDENT then called on Mr. Hope-Jones to make a few remarks relative to the affiliation of other wireless societies in the country.

Mr. F. HOPE-JONES spoke at some length on this matter, and emphasised the importance of such affiliation. It was proposed that, if possible, all provincial and suburban wireless clubs and societies should be affiliated to the Wireless Society of London. The whole subject was at present rather nebulous, but one or two of the societies had already written mentioning the matter of affiliation, and he thought that if a proper scheme and basis could be worked out it might be arranged for in the future. The general rules of the Wireless Society were equally applicable to all the other societies, and if such affiliation could be carried into effect, it would give them as a whole a very much greater force in the country towards securing the desired licences, and also in connection with any regulations that might subsequently be made by the Authorities concerning transmitting work. Mr. Hope-Jones looked forward to the time when club rooms would again be available for the use of members of the Society, and this, of course, would be one of the points

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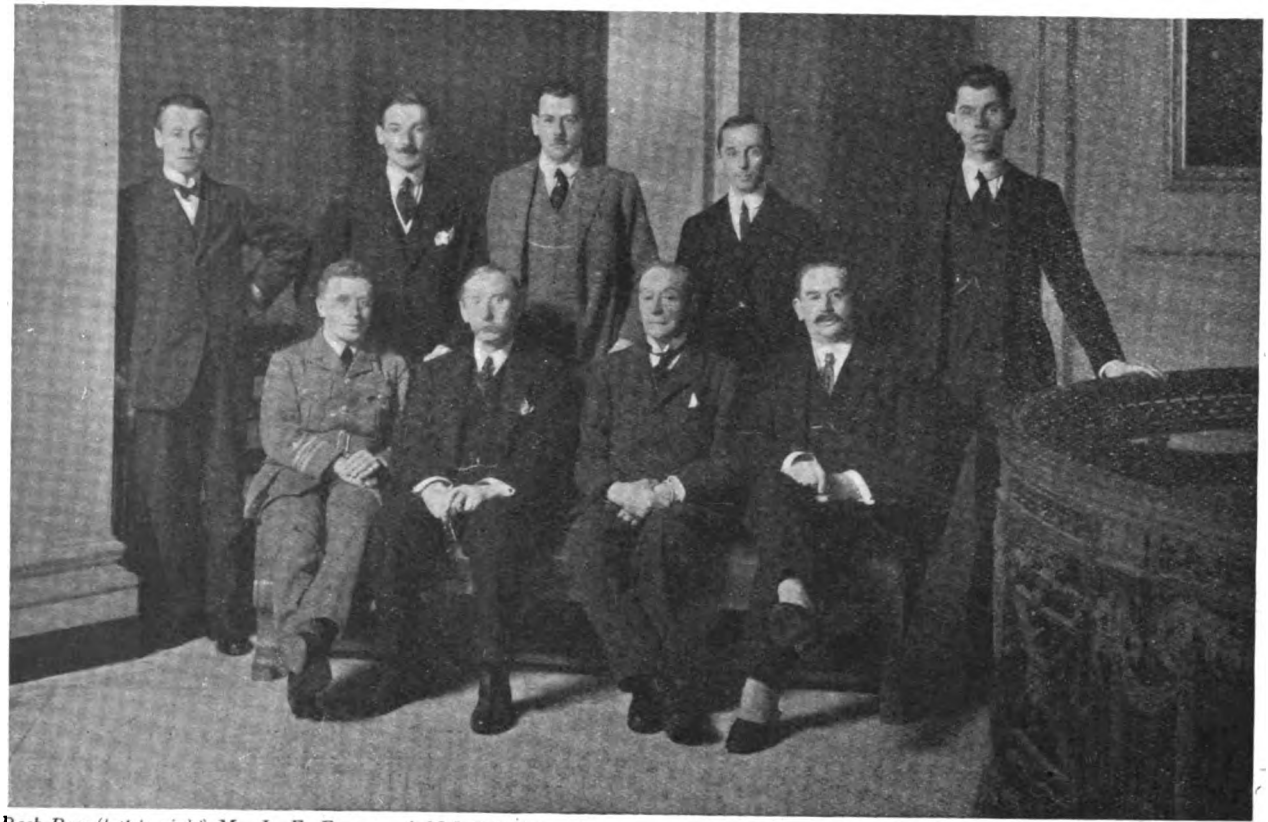
OFFICERS AND COMMITTEE OF THE WIRELESS SOCIETY OF LONDON AT THE INSTITUTION OF CIVIL ENGINEERS, ON OCTOBER 28th, 1919.



Back Row (left to right) Mr. L. F. Fogarty, A.M.I.E.E. (Hon. Treasurer), Mr. R. H. Klein, L.S.C. (Vice-President), Mr. H. L. McMichael (Hon. Sec.), Mr. M. Child, Mr. E. W. Kitchen, A.M.I.C.E.

Front Row (left to right) Dr. J. Erskine-Murray, M.I.E.E. (Vice-President) Mr. Alan A. Campbell Swinton, F.R.S. (President), Admiral Sir Henry B. Jackson, G.C.B., K.C.V.O., F.R.S. (Vice-President), Mr. F. Hope-Jones, M.I.E.E.

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in the affiliation scheme, namely, that the members of all branch societies when visiting London would have the use of the club rooms of the Wireless Society, and he hoped that they would be able to feel that they had the right to enter such club rooms and to make themselves at home there. The current electrical periodicals would be available at such premises for their use, and they would also have facilities to consult the Society's library and to make use of the apparatus that would be installed. It was also hoped that the Wireless Society would be able to offer for distribution by the Secretaries of all the Branch Societies reprints of all the Meetings held in London. This, of course, would be a valuable feature and would serve to bring the affiliated societies into closer touch with one another.

THE PRESIDENT said a few words relative to the provision of club rooms for the Society. Before the war they had had the use of some premises owned by Messrs. Gamage, but these were not now available, and he sincerely hoped that suitable accommodation would soon be found. The matter was a very difficult one at the present time in London as all suitable premises were extremely scarce. The Committee, however, had the matter well in hand and it was hoped that some arrangements would very shortly be made. If permanent club premises could not be secured at the present time, he trusted that they would be able to get some temporary accommodation and expressed the hope that in the near future they would be able to have some really good club rooms in a central part of London.

The list of new members for election to the Society was then read and a scrutineer appointed to collect the ballot papers. It was subsequently announced that these new applications for membership, to the number of about thirty, had been duly elected.

Mr. J. SAYERS made a few remarks relative to the proposed affiliation of the wireless societies of the country. He was, he said, a very great believer in unity, and he thought that it would be very advantageous if the membership of the Society could know as soon as possible what steps had been taken towards affiliation. He also referred to a proposal of which he had heard, namely, that the American Institute of Radio Engineers intended to found a Branch Society over here and he would be glad if the President could inform the meeting whether any action had been taken in this respect as he was sure that no one present would wish to see the existing Wireless Society of London become merely a branch of the New York Institute.

THE PRESIDENT, in reply, said that as far as he was aware the idea of the Institute of Radio Engineers Branch Society in London had been entirely dropped. He also pointed out that the Wireless Society of London was primarily intended to fill up the gap for those radio workers who are not professional electrical engineers, and therefore were not in a position to join the membership of the Institution of Electrical Engineers, or to avail themselves of the wireless section of that Institution. The Wireless Society of London was not therefore running in opposition to the Wireless Section of the I.E.E., but should be an important adjunct to it.

The meeting was well attended, and upwards of two hundred members and visitors were present. In many cases members had come long distances such as from Plymouth, Derby, Bristol, Peterborough and Winchester to attend the meeting, and the Society may congratulate themselves on the success of their first general meeting since the war.

The formal business closed with a vote of thanks to the President and

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Officers for the work they had done and for their offer to carry on in future.

An exhibition had been arranged of some apparatus sent by members of the Society, and the President called on the various exhibitors to give a short description of their apparatus.

MAJOR J. ERSKINE-MURRAY, R.A.F., made a few remarks on the subject of the use of wireless in aircraft. All such apparatus must of necessity be very small and very light and must have as great a power and range as possible. A two-valve C.W. Transmitting apparatus for working on 700 to 2,500 metres wavelength on aircraft was shown. This set has a range of several hundred miles and is fed from a small direct current generator weighing only 10lbs. The receiver for use with the above is a three-valve one, having one detecting and two low-frequency-amplifying valves. This receiver is now standard for use on aircraft. The usual range of wavelength that can be picked up with this apparatus is from 500 to 3,000 metres, but in the set shown special windings were included to enable this range to be extended to 4,500 metres. These sets were usually employed for wireless telegraph purposes, but by the addition of the transmitting microphones they could also be employed for radiotelephony.

A wireless telephone set was also exhibited. (Fig. 1.) This usually operates on a 450 metres wave. The receiver, on the right of the photograph, has three valves, one high-frequency-amplifying, one detecting, and one low-frequency-amplifying. An important feature of this set is that the tuning arrangements and filament control regulator are made up separate from the instruments to which the valves are attached. This is necessary on account of the restricted space in some aircraft, since, of course, the operator need have access only to the tuning gear and to the filament regulator, while the valves themselves can be mounted in a less accessible position. In the illustration these separate control portions can be seen below the valves, and connected thereto by flexible leads. All the parts of this gear

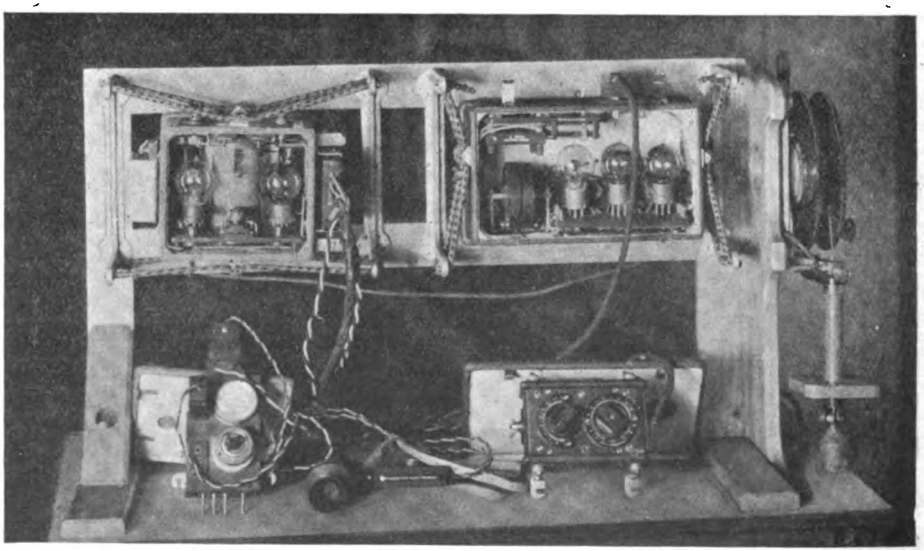

Fig. 1.—R.A.F. Wireless Telephone Set.

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were suspended by rubber in order to minimise damage from shocks and vibration. "French" type valves were employed. In the transmitting part (on the left) two valves were used, one the power valve for generating the oscillations, and one the control valve for impressing the speech current on the emitted waves. The photograph also shows the reel for the aerial wire, and the plummet at the end of that wire.

Direction-finding apparatus for use on aircraft was also shown. The Bellini-Tosi or Artom method of direction-finding with a radiogoniometer was not much use for aircraft as the direction of the waves is given on that apparatus by the position for minimum sound in the telephones. Owing to the proximity of the engines it is extremely difficult to determine accurately this position of minimum sound and a special arrangement was therefore devised by the R.A.F. to overcome this defect. This comprises the two-frame method which was shown. It consists of two frame aerials mounted at right angles to one another. One of these is used to pick up the signals in the ordinary way and is adjusted by rotation until its plane is in line with the transmitting station, when maximum sound is heard in the telephones. The other frame at right angles is then joined in series with the reversing switch and a fine adjustment of the position of both frames is then made until on throwing over the reversing switch there is no change in sound in the tele-

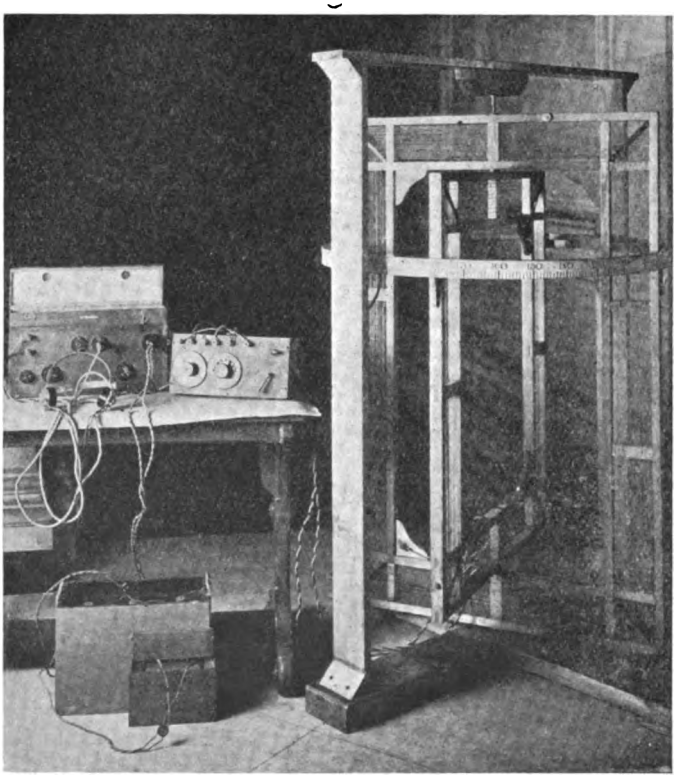

Fig. 2.—D.F. Apparatus with Amplifier used by R.A.F.

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phones. When this is the case the plane of the main receiving coil is then accurately in line with the transmitting station. This arrangement was said to give a very accurate result with aircraft and had been extensively used in long flights. Instances were mentioned in which flights had been made between this country and France in fogs and above clouds, in which the navigation was effected entirely by means of direction determined on the D.F. apparatus. A view of this frame aerial arrangement is shown in Fig. 2. The crossed aerials are seen on the right hand side of this photograph, and the necessary amplifying arrangements on the table on the left with their filament and high-tension batteries on the floor.

Mr. J. SCOTT-TAGGART described the exhibit of the Edison Swan Electric Company, consisting of 15 different types of valves all made by this Company. Amongst these were included a number of service valves, Marconi Company's valves, and other special valves suitable for both transmission and reception purposes.

An extensive exhibit was also arranged showing in detail the construction of an "R" type valve based on the design of the "French" valve. All the parts of the valve were shown, starting from the sheet nickel used for the anode, with the molybdenum wire used for the grid, and the plain glass bulb as received from the glass factory. The grid wire is wound on a special steel rod former having a thread of the proper pitch cut in its surface. After winding the former is removed, the resulting spiral grid straightened out and stiffened by a wire along its length. The sheet nickel used for the anode is 0·008 inch thick. It is cut to the proper size and shape, a tag is stamped out on one side and the piece then shaped into the cylindrical form. The glass stem for supporting the electrodes of the valve has four wires fused through it, and after the electrodes are mounted the completed stem is mounted in the bulb. For this purpose the glass bulb first has a tube fused into one end for the exhaustion process, and the neck of the bulb opened out to fit the assembled stem. These two portions are then sealed together, and the complete valve exhausted. After exhaustion all the valves are subjected to an ageing process, details of which were not, however, given. This process makes the charac-

Fig. 3.—The Scott-Taggart-Ediswan Full-wave Rectifier (small power type).

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teristics of the valve much more uniform and also considerably improves the vacuum. All valves after completion are subjected to rigid tests before they are passed on to the department where the brass collars and caps are attached to them.

Mr. SCOTT-TAGGART also exhibited some special valves designed by himself and for which provisional patents have been taken out. Photographs of two of these valves are shown in Figs. 3 and 4. These included a special double anode "full wave" rectifying valve (Fig. 3). This valve contains two separate anodes surrounding one filament, so that both half waves of an A.C. supply can be rectified in the one valve instead of using two valves as has hitherto been necessary. By the use of this valve it is claimed that more efficient and more economical results are available. Furthermore, it is much cheaper to construct than two separate valves, while the vacuum is identical for both anodes. It is claimed further that almost the full electronic emission from the filament passes to each anode in turn, whereas when two valves are used the filament current of one of them is wasted during alternate half-cycles. High-

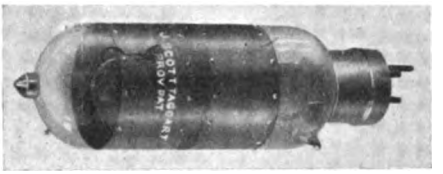

Fig. 4.—Scott-Taggart Continuous-wave Transmitting Tube.

power tubes of this type have been made and have yielded very satisfactory operation.

The special valve shown in Fig. 4 also has a double anode similar to the preceding one, but in addition is provided with a grid electrode. This tube may be used to generate continuous-waves by the application of an alternating current supply directly to the anodes, no separate rectifiers being necessary, since the double anode enables both half waves to be utilised as in the preceding case. This valve when in operation yields a slightly pulsating continuous oscillation, and is therefore suitable for "tonic-train" transmission.

The third type of valve that was exhibited was claimed to be suitable for passing heavy currents at a comparatively low voltage. It was designed for

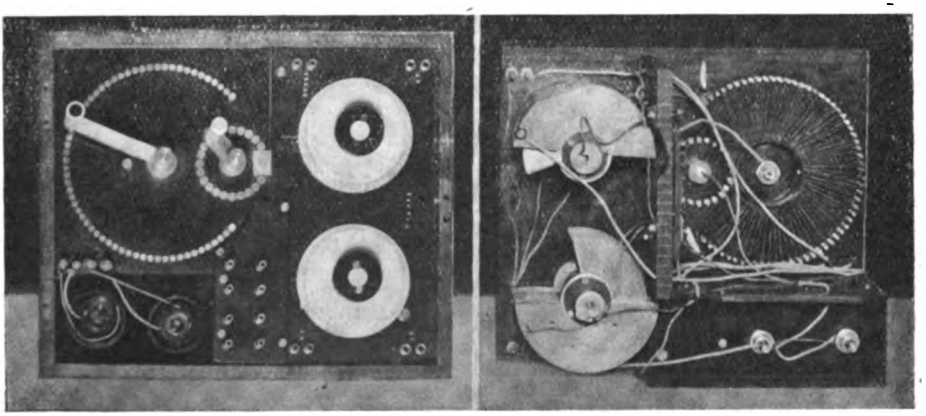

Fig. 5.—Two-valve High Frequency Amplifier. (H. Burbury) Front and back view.

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high-power work, and can handle approximately twice as much energy as any bulb of the ordinary type of the same size and at the same anode voltage.

Mr. H. BURBURY exhibited several instruments made by himself. These comprised (1) a two-valve tuned high-frequency amplifier; (2) a three-valve low-frequency amplifier, having one detecting and two amplifying valves; (3) a valve relay constructed on the lines recently described by Capt. Turner before the Institution of Electrical Engineers, and (4) an ordinary type of heterodyne wavemeter.

The two-valve high-frequency amplifier is shown in Fig. 5, which also gives a photograph of the inside of the same instrument. The rotary variable air condensers can be seen in this photograph, and in particular the special construction of the potentiometer, consisting of a number of radial wires joined between adjacent studs.

The front view of the three-valve amplifier is given in Fig. 6.

The valve relay is particularly interesting. The principle of operation of this relay as described by Capt. Turner,* lies in the adjustment of a three-electrode valve, so that it is *just not* oscillating, and in the arrangement of the connections so that a small e.m.f. impressed on the grid of the valve will cause the oscillations to commence. When this occurs there is a sudden change in the plate current of the valve; this plate current is passed through a sensitive relay which can be seen at the bottom right-hand corner of the front view of the instrument in Fig. 7. At the left-hand top corner of the front of the instrument is the reaction coupling. Further details of this can be seen in the back view,

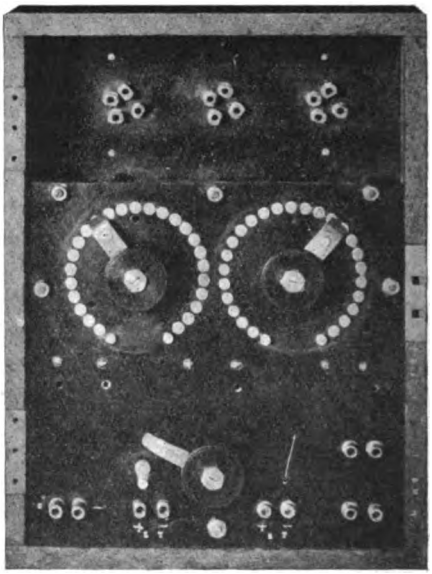

Fig. 6.—Three-valve low-frequency Amplifier. (H. Burbury.)

on the right-hand side. This coupling consists of two cylindrical coils between and inside of which a small spherical coil is mounted and mechanically connected to the adjusting handle on the face of the instrument. A very essential part of this apparatus is the means employed for the accurate adjustment of the potential of the grid of the valve. This adjustment is rather critical as its value determines the magnitude of the additional e.m.f. which must be supplied by the incoming signal in order to start the valve oscillating. The potentiometer used for this purpose must therefore be a finely-divided one and capable of accurate and suitable adjustment. The type used in this instrument of Mr. Burbury's is similar in construction to that described above, and may be seen in the centre of the left-hand side of the back view of the instrument, Fig. 7. The potentiometer wires are threaded through holes in an ebonite annulus mounted concentrically with the contact studs. Mr. Burbury stated that

*Read before Institution of Electrical Engineers, June 30th, 1919. See *Electrician*, July 4th, p. 4.

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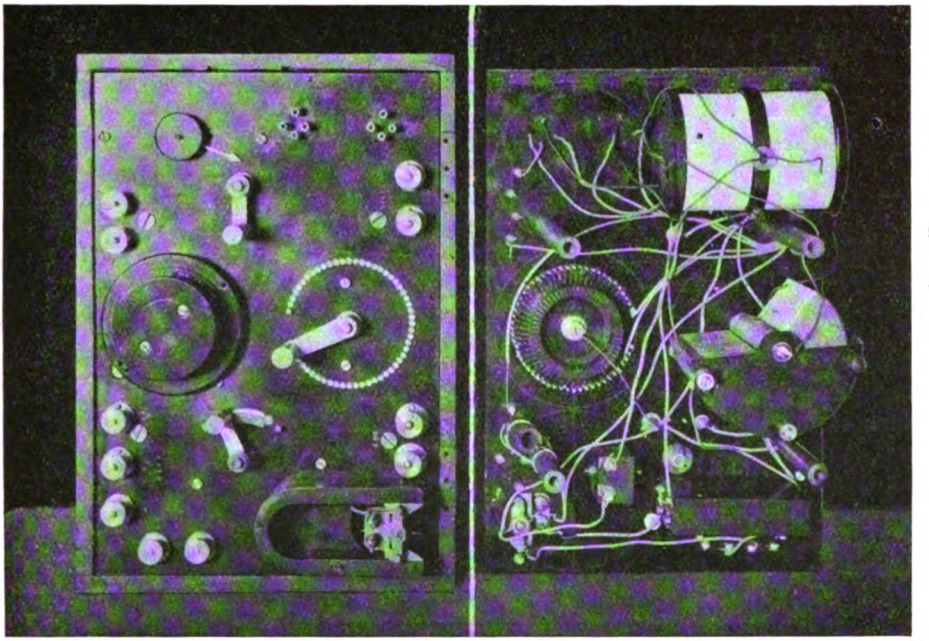

Fig. 7.—Valve Relay (H. Burbury). Front and back view.

this instrument will operate an ordinary Morse inker very successfully, and in fact he had recorded a number of Paris press messages in this manner without any mistake at all. One disadvantage of the instrument was said to be its extreme sensitiveness to C.W. signals, so that when receiving from a spark transmitter a much weaker C.W. signal was liable to cause considerable interference.

Mr. R. KEEN described some exhibits shown by the Marconi Company, comprising a number of small instruments such as "billi-condensers" and similar adjuncts for receiving purposes. One of the $\frac{1}{2}$ k.w. 3-electrode transmitting valves used for the wireless telephone transmitters was also shown. One of the recent "Type 55" seven-valve amplifiers was exhibited. This instrument has a receiving range of from 600 to 5,000 metres wavelength, but gives a maximum amplification between 300 and 800 metres. The amplification obtainable on 2,000 metres wavelength is approximately half that obtainable when working on the optimum wavelength. The central feature of this exhibit was the latest form of radiogoniometer constructed especially for direction-finding

Fig. 8. New Marconi D.F. Apparatus for Ships.

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aboard ships (Fig. 8). This instrument is arranged to be as nearly foolproof as possible and is suitable for use with any ordinary ship's D.F. aerials. The instrument has three separate ranges covering wavelengths between 300 and 5,000 metres. For ship work, direction-finding is of especial utility in navigating intricate passages at the entrance to harbours, etc., and especially for foggy weather. The apparatus has an additional sphere of utility for handling ordinary traffic in crowded waters where there is often considerable jamming, since it may then be used to cut out entirely the signals from an interfering station.

Mr. M. CHILD exhibited a machine captured from the Germans. It has been used for generating the energy for trench "spark" wireless sets. It was a self-contained and self-excited high-frequency alternator of the inductor type yielding a current at 500 cycles. Its normal speed was 4,000 r.p.m. and it was driven by a chain from a tandem bicycle frame. The exhibit was shown especially as an example of a very small and extremely well-constructed generator.

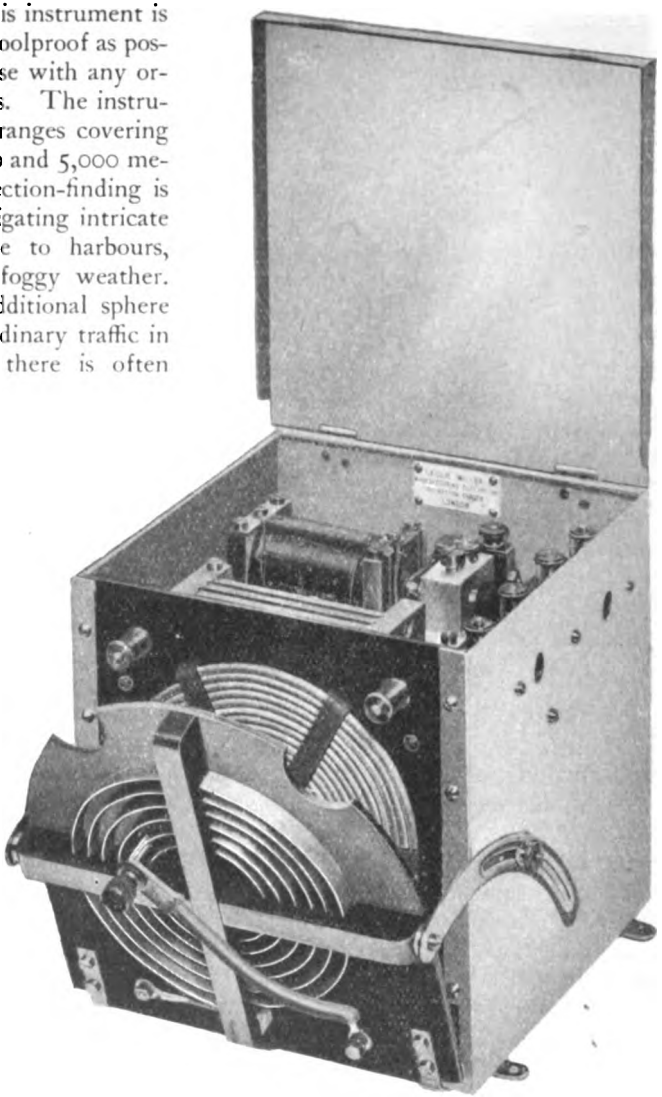

Fig. 9.—Portable Quenched Spark Transmitter.
(Leslie Miller.)

Mr. R. C. CLINKER described some valves exhibited by the British Thompson-Houston Company. Amongst these were:—(1) a 300-watt transmitting valve constructed by the General Electric Company of America for use with a plate voltage of 2,500. (2) A captured German receiving valve of rather low vacuum. (3) A small American transmitting valve having a very small anode to enable it to be operated with the six volt anode circuit battery as used for illuminating the filament. (4) A small "French" valve constructed with

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specially high vacuum for transmitting purposes. This valve of the same size as an ordinary "French" receiving valve could yield 30 watts of high-frequency energy with 1,500 volts in the plate circuit. (5) An American receiving valve.

A special variable condenser was also shown constructed particularly for use in C.W. receivers. It has a separate single plate moveable vane in addition to the ordinary ones, and is suitable for obtaining an extremely fine adjustment such as is advantageous in heterodyne work. A particular feature was the arrangement of the single handle to control both adjustments.

Mr. LESLIE MILLER showed two small portable transmitters, one suitable for use on a 200-volt D.C. supply, and the other on a much lower voltage. Both these sets are furnished with quenched spark gaps. The high voltage set operates on the principle of utilising a condenser discharge to furnish medium-frequency alternating current from the D.C. supply, through the medium of a vibrating contact maker. This principle has been utilised in a number of similar portable wireless sets, and its successful operation depends on the tuning of the speed of vibration of the contact maker to the natural electrical oscillation frequency of the circuit. This frequency may be made round about 500 to 1,000 per second, thus getting a musical note at the quenched spark gap. A photograph of one of these sets is given in Fig. 9.

CAPT. DONNISTHORPE, R.E., exhibited a Selenium cell, a captured German valve, and a U-type rectifying valve, but these exhibits were not described in detail.

THE PRESIDENT, Mr. A. A. CAMPBELL SWINTON, exhibited some receiving apparatus constructed entirely in his own laboratory and pointed them out especially as examples of what could be done with very limited appliances and very few tools. The group of apparatus is shown in Fig. 10. It comprises an octagonal frame aerial mounted on a small base with a compass card, and capable of rotation in order to determine the direction of the incoming waves. On the right-hand side of the picture a seven-valve amplifier can be seen constructed for use with this frame. "French" type valves are employed and an ordinary type of resistance-capacity coupling

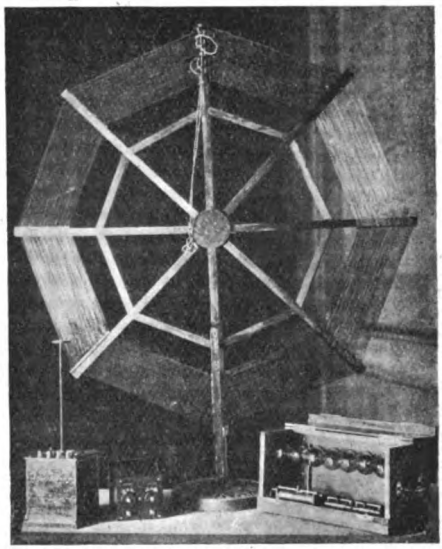

Fig. 10.—Small frame Aerial and Seven-valve Amplifier (A. A. Campbell Swinton).

is used between the valves. With a four-volt battery for the filaments and an 80 to 100-volt battery for the plate circuits of this amplifier, and with the addition of a variable condenser for tuning the frame, almost any large European Station can be picked up with this arrangement, while in many cases the signals are so loud that they can be heard all over the house. On the left hand side of the picture there is a small coupling coil for use with heterodyne receivers, the special feature being a long

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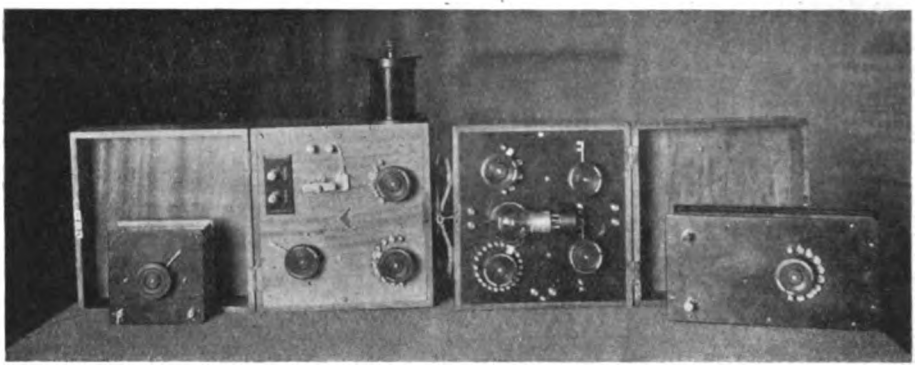

Fig. 11.—Crystal and Valve Receivers.
(F. Reed.

handle to avoid disturbance of the tuning by the hand of the operator.

A set of receiving apparatus was exhibited by Mr. F. REED. This is illustrated in Fig. 11. The instrument on the left is a complete crystal receiver with loose coupling—the coupling handle can be seen pulled out at the top. The small box standing at the extreme left is a variable condenser for tuning the aerial circuit of these instruments. On the right-hand side is a special single valve receiver. It was claimed that this particular receiver would give results as good as almost any three-valve amplifier of the ordinary pattern. A single "French" type valve is used. The scheme of connections used with this receiver is given in Fig. 12, from which it will be noted that the receiver connections are joined between the grid and anode of the valve, instead of between the grid and filament as in the usual arrangements. The condenser C_2 is an ordinary grid condenser of very small capacity, while C_3 is a special variable condenser joined between the grid and the filament. This condenser serves partially to control the wavelength of reception, but more especially to determine the frequency of the local oscillations when using the instrument for C.W. reception. Either spark or C.W. signals can be picked up with this gear by proper adjustment of this condenser. The telephones T are joined in series with the plate battery B_2 in the usual manner, while C_1 L_1 is an ordinary receiving tuner. The aerial tuning coil L and secondary L_1 are external to the instrument shown in Fig. 11. The small box at the extreme right of the photograph (Fig. 11) is the high-tension battery with its selector switch for use with this valve receiver.

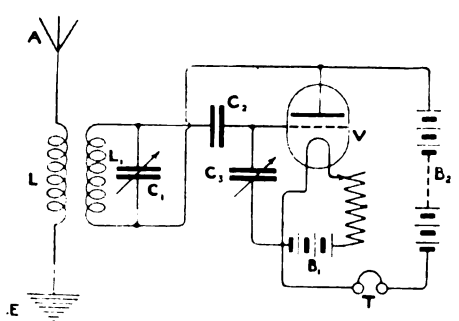

Fig. 12.—Connections of Reed's Valve Receiver.

The proceedings of the meeting closed with a hearty vote of thanks to the exhibitors, both for bringing up their apparatus and for describing it. The various exhibits were closely examined by the members present at the close of the proceedings.

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Notes of the Month

TWO NEW COMPANIES.

THE Marconi - Osram Valve Company, Limited (private company), was registered on October 20th with a capital of £100,000 in £1 shares. The objects are to carry on the business of manufacturers of, and dealers in, electrical valves and other articles, instruments, apparatus and things used in connection with wireless telegraphy, and to carry on the business of electrical and general engineers, manufacturers of telegraphic works and appliances of all kinds. The number of directors is to be either two or four, half to be appointed by Marconi's Wireless Telegraph Co., Ltd., and half by the General Electric Co., Ltd. Registered Office: Osram Works, Brook Green, Hammersmith, W.

Marconi's Wireless Telegraph Co., Ltd., have sold to the General Electric Co., Ltd., of New York, U.S.A., the whole of their shareholding in the American Marconi Company at an advantageous price, subject to resolutions to be submitted to the shareholders of the American Marconi Co. on November 20th being approved. A new Company, the Radio Corporation of America, has been formed, which it is proposed will buy the assets of the American Marconi Co. An agreement has been entered into by Marconi's Wireless Telegraph Co., Ltd., with the General Electric Co., and the Radio Corporation, which provides that the English Marconi Co., secures the sole rights for the whole of the British Empire and a licence for other parts of the world other than the United States of all radio patents and inventions of the General Electric Co. and the Radio Corporation, past, present, and future until the end of 1945, which include the Alexanderson High Frequency Alternator.

* * *

NEW WIRELESS STATIONS.

A wireless station for exclusive military use is to be built this year at Kamishi, a town in the Ishikawa prefecture, facing the Sea of Japan.

The Portuguese government is considering purchasing from the British Navy the wireless installation now at Madeira. The apparatus would be transferred to Porto Santo and a more powerful station erected in Madeira.

* * *

RETIREMENT OF THE "ELECTRICIAN" EDITOR.

On October 31, Mr. W. R. Cooper, M.A., B.Sc., M.I.E.E., A.M.I.C.E., was presented by his colleagues of Benn Brothers with a silver rose bowl and Weston portable milli-ammeter, upon his retiring from the editorial chair of the *Electrician* after a period of 13 years. Mr. Cooper has decided to devote the whole of his time to his consulting practice, the growth of which renders it impossible for him to continue his editorial duties at the same time. Mr. Cooper was appointed Editor of the *Electrician* in 1906, and under his editorship the journal has made considerable progress. His place will be taken by Mr. F. H. Masters, O.B.E., A.M.I.E.E., who was chief assistant editor at the outbreak of war in 1914. Mr. Masters received his technical training at King's College, London, and Finsbury Technical College, under the late Prof. S. P. Thompson. During the war he was engaged on coast defence

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electric lighting work and on searchlights used against enemy aircraft. Mr. Masters was twice mentioned in despatches.

* * *

LECTURES ON WIRELESS TELEGRAPHY.

Amongst the series of lectures projected to be delivered during the coming winter at the Merchant Venturers' Technical College, Bristol, is one about Wireless Telegraphy, by Professor Marchant, of Liverpool University.

* * *

THE GREAT WIRELESS SILENCE.

On November 11th, the anniversary of Armistice Day, all the wireless stations of Marconi's Wireless Telegraph Co. and of the Associated Companies within the Empire ceased work for two minutes at 11 a.m. as a tribute to the Empire's glorious dead.

* * *

NEW MARCONI DIRECTOR.

The Rt. Hon. Lord Herschell, K.C.V.O., has been elected a Director of Marconi's Wireless Telegraph Co., Ltd., and The Marconi International Marine Communication Co., Ltd.

* * *

WIRELESS TELEGRAPHY IN PORT.

With reference to the notice which appeared in the WIRELESS WORLD (November) relating to the arrangements made for inter-communication by wireless telegraphy between ships while in ports of the United Kingdom, the Ministry of Shipping announces that the special circumstances which gave rise to these arrangements no longer exist, and that the previous regulations under which the use of wireless telegraphy by ships in harbour is prohibited except with the written permission of the Postmaster-General are again in force.

* * *

LECTURES ON VALVES.

On Wednesday, October 29th, Prof. J. A. Fleming, F.R.S., delivered the first of a series of six lectures on Thermionic Detectors, Oscillators and Amplifiers in Telegraphy and Telephony.

The lecture was chiefly devoted to an exposition of the electron theory and dealt with the emission of electrons from heated filaments composed of various substances.

On November 5th, the second lecture dealt with the Fleming two-electrode valve and the methods used for producing high vacua.

The same subject was dealt with in the third lecture on November 12th. Dr. Fleming went on to describe the use of the Fleming valve for the rectification of A.C., two experiments being given to illustrate this. The three-electrode valve was then considered and a detailed explanation was given of the control of plate current by grid potential.

* * *

WIRELESS MEN DECORATED.

Order of the British Empire. C.B.E.—(Military Division.)

Hon. Lt.-Col. H. Airey, R.M.—For valuable services in connection with wireless telegraphy.

O.B.E.—(Naval Division.)

Lt. W. G. Bishop, R.N.—For valuable services in connection with wireless telegraphy.

Lt.-Comm. G. Key, R.N.—For valuable services in connection with wireless telegraphy.

Comm. E. J. Prendergast, R.N.—For valuable services in connection with wireless telegraphy.

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O.B.E.—(*To be Member of the Military Division of the said most Excellent Order.*)

Lt. W. A. Appleton, R.N.V.R.—For valuable services in connection with wireless telegraphy.

Actg.-Wt.-Armr. G. P. Pitt, R.N.—For valuable services in connection with wireless telegraphy.

WIRELESS CLUB NOTES.

The Wireless Society of London.

Application for Membership should be addressed to the Hon. Sec., Mr. H. Leslie McMichael, 32, Quex Road, West Hampstead, N.W.6.

Mr. J. Scott-Taggart will read a paper before this Society on November 26th.

* * *

Stoke-on-Trent Wireless Club.

Will anyone interested in or intending to join this Club kindy communicate with the Acting-Secretary, Mr. F. Shaw, 55, Alexandra Rd., Longport, Staffs.

* * *

The Wireless and Experimental Association.

The past has been a month of great expectations and interest for the members of the Experimental and Wireless Association meeting every Wednesday at 16, Peckham Road, for many members have by now obtained permission to receive or endeavour to receive signals on the small amount of aerial allowed by the Authorities.

The old licencees' apparatus, too, is slowly and deliberately filtering back out of P.O. custody, generally in none too good a condition for immediate use, but good signals have been obtained.

Captain Owen, of the R.A.F., has for two meetings interested, instructed and delighted the members with his thorough and interesting lectures on receiving on small sets, the necessity for studying which was forced upon him by the exigencies of space on an aeroplane.

New members are still coming in, but still there is room for more.

A programme based on "making the most of a little" is planned for the immediate future.—Hon. Sec., Mr. F. H. Gribble, 48, Surrey Square, S.E.17.

* * *

Three Towns Wireless Club.

October 4th—Mr. J. Jerritt presided. Mr. Lock lectured on the working and construction of Induction Coils. A letter from the Milwaukee Amateurs' Radio Club, U.S.A., was read by the Hon. Sec. It stated: "We are glad to see that the radio amateurs in England are organising. We are very interested in your Secretary's question of leaguing all the Radio Clubs together, and we do not see why this cannot be international as well as national. We would like to see co-operation among the radio amateurs of all countries, and a great international association formed for the exchange of ideas, etc." The Hon. Sec. stated that as the Wireless Clubs of Great Britain were organising it would be a great thing if all joined up internationally.

October 10th.—Mr. Jerritt presided, and an interesting lecture was given by Mr. Voss on Alternators. Diagrams were drawn and the construction of several types were shown, such as those built for lighting, etc.; also High-Frequency Alternators as used in wireless telegraphy. The Marconi and the Goldschmidt machines were ably explained. Mr. Voss was complimented by the members on the clearness of his lecture.

October 17th.—The Chairman was Mr. J. Jerritt. The lecture was by Mr. Lemin, late R.F.C., of Saltash, on the Lucas Bros. Signalling Lamp. This

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lamp was shown in pieces, also intact, and all parts were ably explained. It is lit by electricity and is carried by one man, and has been read with a telescope at 74 miles under good conditions.

October 22nd was spent in Morse practice, and arrangements were made for a Social on November 5th.

October 29th.—A discussion of the leaguing of all the Radio Clubs took place, and a letter was read stating that a scheme has been started in America by a Radio Club at Omaha, U.S.A., and that it is called the International Society of Radioists. The Three Towns Wireless Club has been appointed the headquarters for Great Britain, and a Relay is being proposed from America to this country. Rules and particulars of membership are being forwarded to all clubs in due course. Apply for membership to Mr. W. Rose, Hon. Secretary, 7, Brandreth Road, Compton, Plymouth.

Some members of the Three Towns Wireless Club enjoying a field day.

* * *

Sheffield & District Wireless Society.

The Opening Meeting of the Session was held in the Mappin Hall, Sheffield University, on October 2nd, when the President, Mr. H. E. Yerbury gave the Presidential Address to an appreciative audience of members and friends.

In response to the wishes of those present, it was decided to print the Address and distribute copies to all the members.

A very interesting exhibition of component parts of wireless receiving apparatus, kindly loaned for the occasion, was afterwards held, and proved a source of great interest to the members.

The weekly meetings of the Society are being held temporarily at the Sheffield Municipal Officers' Club, and the first meeting took place on October 10th when buzzer practice was commenced.

A series of 14 fortnightly papers given by members has been arranged, the subjects covering the various phases of wireless work. The first of the series, on "The Principles of Wireless Transmission," was given on October 17th by Mr. C. H. Hainsworth, who dealt with the subject in a very lucid manner, illustrating his lecture with numerous diagrams and experiments.

The Hon. Secretary invites applications for membership, which should be addressed to 156, Meadow Head, Norton Woodseats, Sheffield.

* * *

The Manchester Wireless Club.

It has been decided to form a Wireless Club in Manchester. Will all those interested kindly communicate with the Hon. Secretary, Mr. J. C. A. Reid, 16, Hawthorne Avenue, Monton, Eccles, Lancs.

* * *

North Middlesex Wireless Club.

A meeting of the Club was held on

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November 4th at Shaftesbury Hall, Bowes Park, at 8.30 p.m. The chair having been taken by Mr. Reed, he called on Mr. D. J. Stone to give his promised lecture entitled "Five Years at Sea as a Marconi Operator." Mr. Stone commenced by telling his audience how he had first become attracted towards wireless operating while on a voyage to Genoa on a holiday, and as he was already a keen amateur, on joining the Marconi School it was not long before he obtained his P.M.G. certificate, and was sent to sea. A few months afterwards the War broke out, and Mr. Stone had a number of thrilling adventures. It was clear that, on the whole, Mr. Stone's life at sea had been an enjoyable experience, and one on which he was able to look back with pleasure.

It has been arranged to form a library in connection with the Club, and members who have any technical books that they would be prepared to present or lend to the Club, should get in touch with the President, Mr. A. G. Arthur, 45, Westbury Road, Bowes Park, N.22.

Full particulars of the Club may be obtained from the Hon. Secretary, Mr. E. M. Savage, Nithsdale, Eversley Park Road, Winchmore Hill, N.21.

* * *

NOTICE TO HON. SECS. OF WIRELESS CLUBS.

A Wireless Club is being formed at Burton-on-Trent. All interested please apply to the Hon. Sec., Mr. Rose, 214, Belvedere Road, Burton-on-Trent.

* * *

We shall be pleased to publish notices and reports of your meetings, free of charge. Kindly endeavour to submit these not later than the 1st of each month.

WIRELESS TRANSMISSION FOR AMATEURS

The following are the eagerly-awaited official rulings regarding transmission. A new Wireless Telegraphy Bill will be introduced into Parliament, and when this is passed the various forms of licences will be revised.

EXPERIMENTS IN WIRELESS TELEGRAPHY.
AUTHORITY FOR SENDING.
SUMMARY OF CONDITIONS OF ISSUE.

(*Note*:—*All Sending Stations must also be equipped for reception.*)

(1) Applicants must produce evidence of British nationality and two written references from persons of British birth and of standing, not related to them.

(2) Installation to be approved by Postmaster-General.

(3) Secrecy of correspondence to be observed.

(4) Applicants must satisfy the Postmaster-General that they have in view some definite object of scientific value or general public utility. If scientific research is intended they should be certified as competent investigators by a Government Department or some recognised scientific body.

(5) Applicants will normally be required to show that they have attained:—

(a) A sufficient knowledge of the adjustment and operation of the apparatus which they wish to work;

(b) A knowledge of the regulations of the International Convention in so far as they relate to the prevention of interference and impose certain duties on all wireless operators (these are contained in Section V of the Postmaster-General's Hand-Book for Wireless Operators which is sold by the Stationery Office);

(c) An operating speed of at least 12 words (Morse) a minute, sending and receiving.

A fee of 5s. will be charged in connexion with this arrangement.

A licensee may be allowed, exceptionally, to employ a certificated operator, whose name should be furnished.

(6) It is proposed to charge small fees to cover clerical expenses and expenses of inspection, etc.

(7) Communication will be authorised only with specified stations not exceeding five in number.

(8) *Aerials.*

(Same dimensions as for receiving.)

(9) *Portable Stations.*

General conditions same as for fixed stations.

Power of portable sending stations will usually be limited to 10 watts.

Use will ordinarily be authorised only within 10 miles of a fixed point.

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The Design and Construction of an Amateur Receiving Station

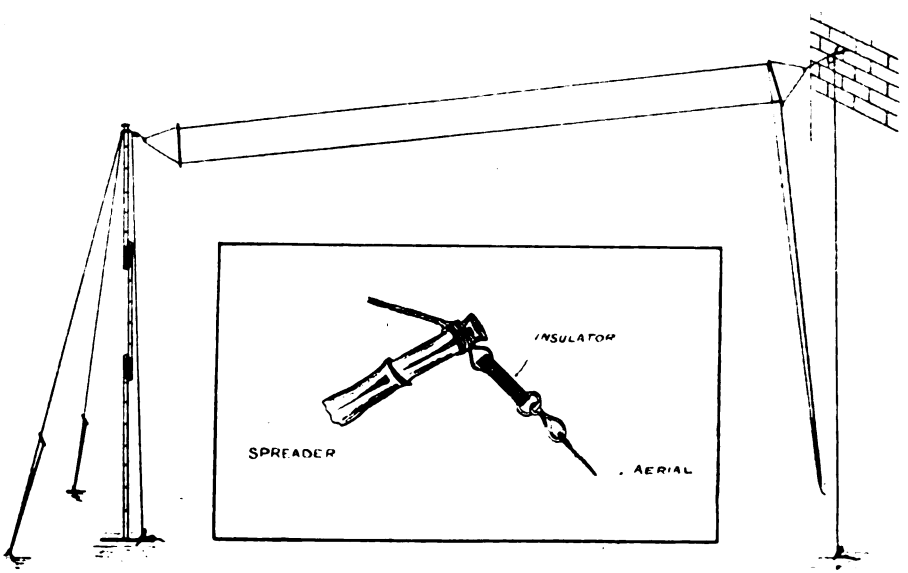
By A. D. KENT.

NOW that the ban on Amateur Wireless has been partially lifted, we can go ahead with work of a practical nature. In many previous articles the principles underlying the reception of wireless signals have been fully dealt with, and it is now proposed to give our readers as much help as possible with the design and construction of apparatus suitable for amateur work.

The present article outlines the construction of a simple form of Crystal Receiver which will be inexpensive and yet do useful work. Its wavelength range will be such as to receive signals from ships, Time signals and Press from the Eiffel Tower, Poldhu and any other "Spark" stations working on wavelengths up to 3,000 metres or thereabouts.

THE AERIAL.

Take the case of the average amateur who has to use the wall of the house as a fixture for one end of his aerial and a light mast at the end of the garden for the other end. Most gardens will allow a 50 or 60 foot span and the wires should be placed as high above the ground as possible,—as the range of a transmitting or receiving station is directly proportional to the height of the aerial with small power sets. It is usually most convenient to rig the aerial up at one end to a window at the top of the house, and use, say, three or four stout



Figs. 1 and 2.

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bamboo poles lashed together at the other end; this pole must be suitably guyed to take the strain of the aerial. This arrangement would give the Aerial an average height of about 20 feet from the ground. (See Fig. 1.) As better results will be obtained with a twin wire aerial, it is necessary to have two 3-foot bamboo poles to act as "spreaders." The Aerial wires should not be attached directly to the spreaders, they should be insulated from them; therefore four small porcelain, ebonite, or fibre insulators must be obtained. The ends of the two wires should have "eyes" fitted to clip on to dog snaps on the insulators (Fig. 2). The two lengths of wire should be sufficiently long to act as down-leads and should not be joined except at the leading-in wire, and they should not be connected together at the far end. The most suitable wire to use is 7/19 S.W.G. bare, stranded, phosphor bronze, or silicon-bronze wire, as this will allow the Aerial to be lowered when necessary without the wires curling up into a tangle. If this wire cannot be obtained, ordinary hard-drawn bare copper wire of not less than No. 18 S.W.G. may be used. The "lead-in" may be of ordinary rubber-covered cable; this may be joined to the Aerial wires by means of an ordinary cable connector or a well-twisted, soldered joint.

THE EARTH.

With most amateur stations it is not very convenient to bury large earth plates in the ground so recourse is made to the water pipes of the house. A good "earth" can be made in this way if the connection is made as near as possible to the ground. A length of wire netting, 15 inches wide and 15 feet long, also is very useful, especially if covered with slightly moist soil.

We now come to the RECEIVER (Fig. 3). From the diagram it will be seen that we are using a "plain" aerial

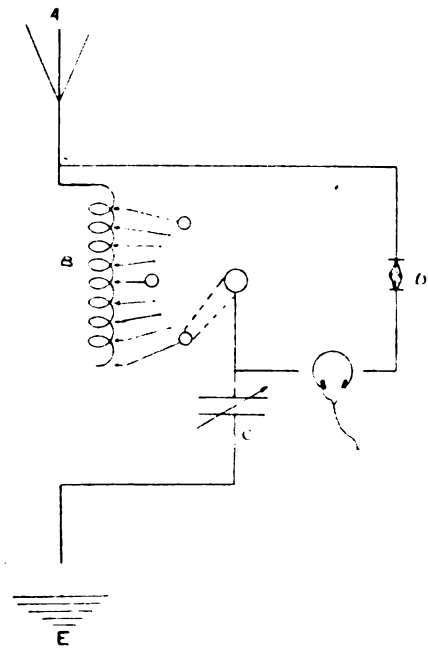

Fig. 3.

circuit, having a variable inductance and a variable condenser in series, with a crystal rectifier and telephones connected across the inductance. To make the INDUCTANCE FORMER which should have a winding diameter of $6\frac{1}{2}$ inches, obtain two hard dry wood discs, 7 inches diameter and $\frac{1}{2}$ inch thick, and eight pieces $\frac{1}{2}$ inch square or $\frac{1}{2}$ inch round and mount them as shown in sketch, Fig. 4. The length of these pieces will vary according to gauge of wire used (see table). Before mounting, cut a 3-inch diameter hole in one disc to bring the tappings through to the switch. Mount two terminals on this disc. Obtain another wooden disc, 4 inches diameter and $\frac{1}{4}$ inch thick, for a switch base, and on this mount, say, ten contacts—using metal-threaded screws and nuts—the nuts underneath and the screw-heads filed down to act as contacts. Mount a small brass switch arm in the centre of the contact circle and just suf-

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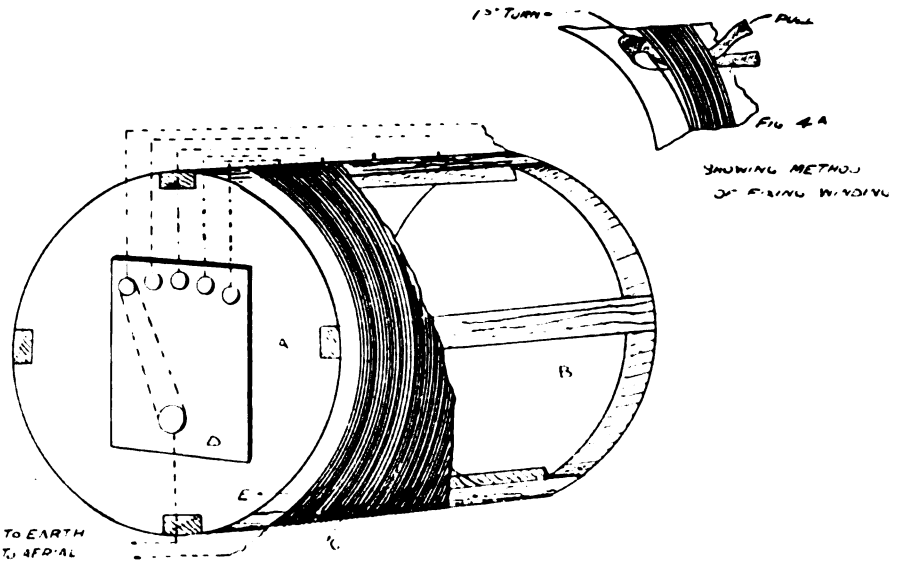

Fig. 4.

ficiently wide to make contact on one stud at a time.

Now for the WINDING. Assuming the capacity of the two wire aerial to be approximately 0·0003 mfd., an inductance of 8,500 microhenries will be necessary to tune it to 3,000 metres. The number of turns necessary are given in the table below for three gauges of copper wire. Commence winding at the end of the former nearest the switch and wind as tight and close as possible. Make nine evenly spaced tapping points. These may either be made by slipping a small piece of ebonite $\frac{1}{8}$ inch thick under the turn to be tapped and then soldering a connecting wire on, or by leaving a long loop at the tapping point giving the loop a twist and then continuing to wind. If the tappings are made by means of loops, these can be pushed inside the former, and afterwards brought up through the end of the former to the switch contacts. If tappings are made by slipping ebonite blocks under the turns, the connections to the switch must be made on the outside of the former and not through the centre. If carefully done the looping method is the best. The tappings should be connected to the switch contacts in order—the first tapping to first contact and the end of the winding to the last contact. The beginning of the winding should be connected to one terminal and the contact arm of the switch to the other. Commence winding $\frac{1}{4}$ inch from the end cheek, and make the winding secure at both ends by slipping a doubled-over piece of tape under the first few turns (Fig. 4a), putting the first turn through the loop in the tape, and then when the tape is almost covered pulling it tight so that the tape is holding the first turn and is held down itself by the other turns.

WINDING TABLE.

	TURNS	LENGTH OF FORMER
No. 22 D.W.S.	320	10¾ inches
No. 24 D.W.S.	285	8 inches
No. 26 D.W.S.	260	6½ inches

Amount of wire, ¾lb. either gauge. The wire should be double silk covered.

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THE AERIAL TUNING CONDENSER is provided to tune to wavelengths between those given by the tappings on the tuning inductance. The maximum capacity of the condenser should be approximately 0·001 mfd. A variable circular vane condenser is not very easy to make up and should preferably be purchased complete. A useful condenser might be constructed as shown in Fig. 5. Two pieces of ebonite are grooved to take metal plates which may be of copper or brass, 1/32 inch thick and about 3 inches square of actual working surface. There should be about 30 plates spaced 3/32 to $\frac{1}{8}$ inch apart. The grooves in the ebonite should be of sufficient depth to hold the plates rigid. A box must be made sufficiently large to take the condenser when mounted and a false bottom of ebonite provided for the plates to bed down on. The plates should be mounted as shown in the diagram with the shaped ends of alternate plates reversed. Alternate plates should be connected by a soldered wire, making two sets each of 15 plates. One set should be free to move smoothly in the grooves. The condenser is now complete, and providing it is kept clean and free from dust, will be quite an efficient receiving condenser. If preferred, the false bottom may be of metal; the condenser can then be short-circuited if desired, without an extra switch.

THE CRYSTAL. — Carborundum is the best all-round crystal, but its one disadvantage is that it requires a potentiometer and battery to apply a small potential to the crystal. In order to avoid using a potentiometer, we use as a rectifier a combination such as Zincite-Bornite, which will give good signals, but will not stand so much rough usage as carborundum. A small piece of each should be mounted in small brass cups with solder, or Wood's metal if possible, as this has a low melting point and consequently the crystal is not heated so much when melting occurs. The cups must have brass stems fitting into two brass supports with fairly weak tension springs as shown in Fig. 6.

TELEPHONES.—It will be very convenient for the amateur to use high resistance telephones directly in the crystal circuit. There is not a great difference in the cost between high resistance telephones and low resistance ones with a transformer; also, unless the transformer is well-designed and wound, there will be a big drop in the efficiency of the set. Present-day high resistance telephones are the order of 2,500 ohms

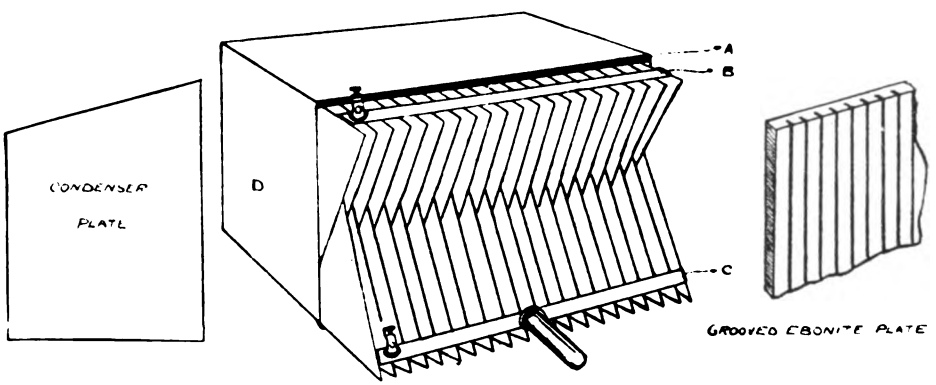

Fig. 5.

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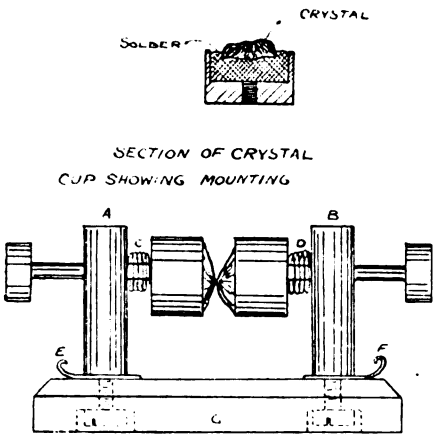

COMPLETE CRYSTAL CUP
Fig. 6.

per head piece, 5,000 ohms in series. To put the receiver into operation, connect up the circuit as shown in Fig. 3, and see that all connections are well made. It is a good plan to have the first test of the set one afternoon, commencing at 3 p.m., Greenwich mean time, when Eiffel Tower (FL) sends press for twenty to thirty minutes each day on 3,200 metres. Short-circuit the Aerial condenser, and put all the inductance in the circuit, which will then be approximately in tune to 3,200 metres. Then carefully adjust the crystal until signals are heard. Get the best crystal adjustment and adjust the aerial inductance and condenser for best signals. The tuning point for the ship wavelength of 600 metres will be approximately between the second and third tappings.

HOW AMATEURS CAN COMBINE BUSINESS WITH PLEASURE.

We feel that the time is now ripe to devote more space to practical matters of direct interest to the private experimenter. Although we by no means intend to neglect the theoretical aspect of wireless work, and shall continue to keep our readers in touch with its latest developments by means of technical articles by competent writers, we shall also provide that class of matter which appeals so strongly to amateurs who like to make their own apparatus. We have already made a start along these lines, by publishing our series entitled "The Construction of Amateur Wireless Apparatus," and the present number contains still further evidence of our intention to serve the needs of practical amateurs.

There must be many of our readers who have evolved in their workshops ingenious contrivances of "wireless" interest or have designed some special form of apparatus for special purposes, but who have never thought of publishing a description of them for the benefit of their fellow-amateurs. We therefore invite them to write to us about them, giving all necessary dimensions and connections for the construction of the apparatus they describe. Payment for all such articles published in the WIRELESS WORLD will be made at our standard rate. Photographs and descriptions of complete amateur stations will also be welcomed. If you are not an expert draughtsman do not let that fact deter you; we will work up your rough sketches and diagrams. A few articles accepted and published by us means more spare cash for you to spend on valves and H.T. batteries.

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THE AMATEUR'S GUIDE TO THE AETHER.

Below we give a list of certain long wave Shore Stations in which Amateurs in Great Britain are most likely to be interested, together with data whereby they may be identified. Except in the cases of Time and Weather signals (see Year Book of Wireless Telegraphy and Telephony, 1919), the times of transmission are very liable to vary.

Station.	Call Letters.	λ	System.	Remarks. (All times G.M.T.)
Arlington	NAA ...	6000 m. ...	C.W.	
Berlin	LP ...	5500 m. ...	Spark	Transmits at 7 p.m.
Carnarvon (Wales)	MUU ...	14000 m. ...	C.W.	Works irregularly to EAA. Press at 7.0 a.m., 9.0 a.m., 4.30 p.m, and 6.0 p.m.
Clifden (Ireland) ...	MFT ...	3500 m. ...	Spark	Works irregularly throughout day and night.
Coltano	ICI ...	6500 m. .	Spark	Works at 4.0 a.m. and sends programmes at various times during afternoon and evening.
Eiffel Tower ...	FL ...	2400 m. ...	Spark	Astronomical Time Sigs. 11.29 p.m.
		2600 m. ...	Spark	Weather Reports. 9.45 a.m., 4.0 p.m. Time Sigs. 9.56 a.m., 10.2 a.m., 10.44 a.m. and 11.44 p.m.
		3200 m. ...	Spark	Press. 3.0 p.m.
		8000 m. ...	C.W.	Press. 1.0 a.m., 4.30 a.m. and 6.0 p.m.
Eilvese (Hanover)	OUI ...	15000 m. ...	C.W.	Works irregularly to EAA in early morning.
Gibraltar	BWW	2750 m. (C.W.) 4600 m. (Spk.)	Spark and C.W.	
Glace Bay ...	GB ...	7500 m. ...	Spark	Works to MFT irregularly throughout 24 hours.
Horsea	BYC ...	4500 m. ...	C.W.	Works every *even* hour. Press at 10 p.m.
Lyons	YN ...	14000 m. ...	C.W.	Works most of night from about 1.0 a.m.
Nantes	UA ...	11000 m. ...	C.W.	7.0 a.m., 11.44 a.m., 4.30 p.m., 6.15 p.m.
Nauen	POZ ...	5500 m. ...	Spark	Spark. 7.0 a.m., 9.45 a.m., 11.56 a.m. (Time Sigs.) 3.0 p.m., 5.30 p.m. and 7.0 p.m.
		12600 m. ...	C.W.	
Poldhu	MPD ...	2800 m. ...	Spark	Press at 10.30 p.m.
Rome	IDO ...	11000 m. ...	C.W.	
Moscow	MSK ...	5000 m. ...	Spark	Works at 11.0 a.m., 1.0 p.m., 5.0 p.m. and 10.0 p.m.

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The Library Table

TELEPHONY WITHOUT WIRES.

By P. R. Coursey, B.Sc., A.M.I.E.E.

London: The Wireless Press, Ltd.

(Pp. xix. + 414, price 15s. net.)

THE author of this volume does not state in his preface that his work is designed to satisfy a "long-felt want." Nevertheless, the work really fills a gap in our Radio and our Telephonic Literature. The problem of transmission of human speech by "wireless" methods is here dealt with in an interesting and exhaustive manner. As the title would lead one to suppose, Radiotelephony is not the only subject dealt with. The first three chapters deal with the simple methods of speech communication using induction or earth induction and light wave transmission, including an interesting account of photophones and thermophones. It is well to note that although these methods have to a great extent been superseded in these days of Atlantic Radiotelephony, the exigencies of war-time conditions have provided ample opportunities for their revival. The British Military Authorities were not lacking in discrimination when they placed the trench "listening sets" under the control of the "wire-less" branches of the service.

Fully twenty chapters of the book are devoted to the problems of Radiotelephony. The discussion of the problem of speech transmission (e.g., limits of audibility and modulation of the transmitted wave) is followed by a classification of all the different oscillation generators. The latter are then described in detail. The discussion of "spark" generators deals first with practical forms of the quenched gap followed by an exhaustive account of the methods of obtaining continuous oscillations by these and other spark gaps. This section of the work ends with a chapter on multiphase spark transmission.

Three chapters are devoted to the Arc oscillation generator, the Braun tube oscillographic work of Simon and Yagi on "dynamic characteristics," being fully described. One of the longest chapters of the book is that on vacuum oscillation generators, and to many readers this will prove the most interesting part of the book. All types of valves are described, but a reader might wish for a little more detailed information on modern high-power valves. It is also a pity that the salient points of Fortescue's recent paper (published presumably after this work was in the press) on the design of high-voltage thermionic rectifiers could not have been included.

The subjects of high-frequency alternators and frequency raisers are accorded two chapters, which are extraordinarily clearly written. Students working at this subject for the first time often find the usual arguments relating to the frequencies generated by these various machines rather unconvincing. To such these two chapters can be confidently recommended.

Four chapters are devoted to the subject of microphonic control, every type of microphone of any importance being described, while the remainder of the book deals with the receiving apparatus of Radiotelephony, including, of course, a thorough discussion of telephone relays, ionic valve receivers, and the subject of heterodyne reception.

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A very pleasing feature of the book is the list of nearly seven hundred references to original papers on the subject of Radiotelephony. In the cases of articles reprinted or abstracted in *The Electrician*, *Science Abstracts*, or *The Wireless World*, both the original and abstract references are given. It is impossible to insist too much on the importance of such a reference list in a work of this kind, and the author is to be congratulated on the exhaustive nature of these references and also on the very helpful classification of these under the chapter headings. We are certain that the book will meet with a cordial reception in radio and scientific circles generally. E. V. APPLETON.

ALTERNATING CURRENT WORK.

AN OUTLINE FOR STUDENTS OF WIRELESS TELEGRAPHY.

By A. SHORE, A.M.I.E.E.

London: The Wireless Press, Ltd., IX + 163 pp 3/6 net.

Here is a work admirably suited to the needs of the student of radiotelegraphy, whether he be an amateur or a person intending to make wireless his profession. The wireless man simply must know a certain amount about A.C., but it is by no means imperative that this knowledge should be profound. This book provides an excellent primer for all students who are likely to have dealings with alternating currents. We venture to suggest that if it were adopted as a school text-book for senior science students, together with a companion treatise on D.C. work, and another on technical chemical analysis, there would be registered a landmark in the history of elementary education in this country.

The first three chapters deal with the production of Alternating Current, including sections on current curves, R.M.S. values, and form and amplitude factors; with A. C. generators and rotary converters. Chapter IV. is devoted to the question of Power, and explains the phase relationships between current and voltage in a simple manner. Then follow two chapters on Inductance and Capacity, well illustrated and with worked examples. Chapters on Resonance Transformers and High-frequency Resistance follow, and the text closes with two excellent ones descriptive of electrical measuring instruments. Appended are tables of the squares and reciprocals of numbers from 1 to 10,000, tangents, sines and logarithms.

To attempt an outline of Alternating Current work in less than 200 pages is courageous; to accomplish it in such style as is revealed by the book under review is at once skilful and noteworthy.

The book is well printed, the diagrams are good and the reader has the advantage of the author's practical experience as a wireless engineer.

GUIDE TO THE STUDY OF THE IONIC VALVE,

SHOWING ITS DEVELOPMENT AND APPLICATION TO WIRELESS TELEGRAPHY AND TELEPHONY.

By W. D. OWEN, A.M.I.E.E.

London: Sir Isaac Pitman and Sons, Ltd., pp. VII + 59, 2s. 6d. net.

This is a small collection of short notes which, though not without interest, are of no special value to the serious student of wireless, who nowadays has a number of first-class text-books on the valve at his service, to which, so far as we can see, he has no need to go *via* a "guide."

The volume is well printed and well bound, the only facts which warrant its somewhat high price of two shillings and sixpence for 59 small pages.

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The Construction of Amateur Wireless Apparatus

This series of articles, the first of which was published in our April number, was originally designed to give practical instruction in the manufacture of amateur installations and apparatus, and arrangements had been made with Marconi's Wireless Telegraph Co., Ltd., to supply complete apparatus to the designs it was intended to detail. The restrictions on amateur work, however, remained in force, and the author was compelled to proceed on general lines only. A further series will be published giving the class of information originally intended.

Article Nine.—THE HIGH VOLTAGE BATTERY.

IN using the three-electrode valve, one of the most serious difficulties which at once confronts the amateur experimenter is the question of how he is to obtain the necessary voltage for the plate circuit of his valves. Much will naturally depend on the type of valve used, and whether for transmitting or receiving work. Different types of receiving valves require widely differing plate voltages for best results, the optimum voltage being mainly a question of the mesh of the grid. If the grid is of very open mesh or a simple spiral of metal wire, a fairly low voltage should be used; a close mesh grid means that a high plate voltage will be found best. Commercial three-electrode valves vary in this respect and the plate voltages required may be anything from twenty to two hundred volts or more. For use in the simple receiving circuits we have already illustrated, the amateur will find that he will get the best results by employing a valve which requires a fairly high plate voltage.

In commercial wireless stations the high voltage batteries consist of banks of either dry cells or accumulators, a sufficient number of cells being connected in series to give the E.M.F. required. Since the current required is very small—being only 100-150 micro-amperes in the case of a valve requiring a plate voltage of 200—the cells need only be of small size. Such a battery of dry cells can be very conveniently made up from the small 4-volt batteries used for pocket flash lamps of the flat type. But even if these small cells are used the expense is heavy. The chief disadvantage of dry cells lies in the fact that they deteriorate almost as quickly whether used or not. So that if the amateur constructs such a battery it will only last a certain time and since the initial cost of the battery is high (fifty units being required) it renders valve receiving circuits expensive to run. Accumulator batteries to give a voltage of two hundred can be ruled out of court for the average amateur as the initial cost is very heavy. Also, accumulators are not an unmixed blessing, as at the very slow rate of discharge involved they tend to sulphate rapidly unless carefully watched.

A solution of the difficulty can be found if the amateur has a supply of direct current at about the right voltage in his house. In general, a valve designed for 150 volts plate pressure will

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operate quite well on either 110 or 220 volts, though the magnification may not be the very highest that can be obtained. The suitability of the supply for the amateur's work will have to be determined by experiment. It is necessary that the voltage should be steady—or at any rate not subject to fluctuations sufficiently rapid to cause noises in the telephones loud enough to drown out the received signals. The currents delivered by different generators vary very much in this respect. Some machines are perfectly quiet—others are so noisy that work is quite impossible. *It is absolutely necessary that the amateur should make up a protection board such as we describe below before he attempts to use his house supply for valve work.* This protection board is to ensure that no harm is done should the high voltage supply be accidentally short-circuited. The effects of a short-circuit on the supply may be very serious indeed if the protection board is not used—the apparatus may be badly damaged and the operator burned.

The protection we recommend consists of a small gauge fuse and a low candle power lamp in *each* lead of the supply. This arrangement is illustrated diagramatically in Fig. 1. Here A and

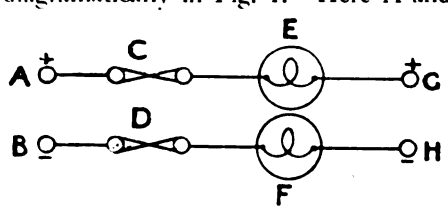

Fig. 1.

B are the positive and negative terminals of the supply, C and D are two fine fuse wires, E and F are two, four- or eight-candle power carbon filament lamps and G and H are the terminals which are used to supply the plate voltage for the receiving circuits. It is clear that should G and H be accidentally short-circuited nothing will happen except that the lamps E and F will partly light up. The lamps E and F should each be the correct type for use on the full supply voltage. There is one other matter on which we would give the amateur warning—never under any circumstances make any alterations in the connections of a valve circuit with the high voltage supply on. Very nasty shocks can be received by ignoring this point. It is an excellent rule in practice *never* to touch two parts of a circuit at the same time with both hands. Use only one hand for making adjustments—in fact it is an excellent plan to form a habit of keeping one hand always in the pocket when adjusting a "live" valve circuit.

Smoothing Out Apparatus.

The practicability of utilising the house supply for valve receiving circuits depends, as we have pointed out, upon the absence of secondary ripples in the D.C. voltage. The ripples may be caused by sparking at the commutator of the generator or by slight irregularities in the armature winding. It should be noted that any apparatus involving the magnification of note frequency current, or in which the telephone circuit is directly in series with the high voltage supply necessitates much more perfect uniformity of pressure than in the case of purely high-frequency amplification. A very suitable circuit for the amateur to make his first experiment on is that shown in Fig. 2 of *Article Seven* of this series. A study of this figure will at once make it clear that none of the current from the high voltage supply directly passes through the winding of the telephone transformer, the only current which can affect the telephones being that produced by the rectification of the high-frequency oscillations in the plate oscillatory circuit. Should, however, the D.C. supply be so unsteady that direct impulsing of the plate oscilla-

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tory circuit occurs, then, of course, an intermittent rectified current will flow through the telephone transformer, producing a sound in the telephones. We therefore recommend the amateur to set up such a circuit and experimentally determine for himself whether his supply is good enough as it stands. Of course, it must be understood that slight noises will almost certainly be heard on even the most perfect supply, the question being to decide whether the noises are such as will drown out the signals which it is desired to receive or not.

Should it be found that generator noises are excessive a system of condensers and chokes can be employed to reduce the effect. Such an arrangement is shown diagramatically in Fig. 2. In this

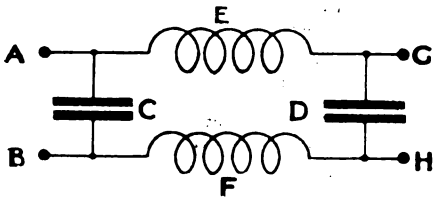

Fig. 2.

figure A and B are to be connected to G and H on the protection board, G and H then forming the terminals from which the supply is drawn for the operation of the receiving circuit. The device consists of two chokes, E and F, shunted on both sides by condensers C and D. Provided that the condenser C is large enough, it will act as a partial short-circuit to any fluctuations in P.D. which are of fairly high frequency, thereby reducing the variations between A and B. The chokes E and F which must be highly inductive further reduce fluctuations by offering a very high impedance to any ripples there may be in the voltage across the condenser C. The condenser D further assists in the smoothing out and acts as a reservoir condenser from which the current can be drawn for the valve. Thus, assuming that the correct values have been chosen for the chokes and condensers and that the original fluctuations are not of a too violent character, we obtain by this means a practically steady potential difference between G and H. As a preliminary experiment, two 2 mfd. paper condensers may be used for C and D and the chokes may conveniently be small ignition coil secondaries. The Mansbridge condenser is a particularly suitable type in view of the fact that it has a high insulation resistance, is practically self-sealing in the event of accidental breakdown, and is cheap. We do not recommend the amateur to attempt to make these condensers; special processes are used in their manufacture involving the use of machinery. Particulars as to windings for the chokes will be given in these pages in due course.

High Voltage Supply for Transmitting Circuits.

For very low power transmitters such as the amateur will probably most generally employ, the arrangements described in connection with the receiving circuits are all that he will require. It is only in extreme cases that any smoothing-out of D.C. is likely to be necessary, so that the terminals of the protection board will furnish the required voltage without further apparatus. In the case of higher powers a greater P.D. is required for the operation of the circuit and where the D.C. supply is inadequate this high voltage can most conveniently be obtained by the rectification of the alternating current from a transformer.

The necessary rectification can be conveniently carried out by means of a two-electrode or Fleming valve and a suitable circuit is shown in Fig. 3. In this figure, A is a step-up transformer delivering alternating current at the required voltage at the terminals of the secondary winding. This alternating

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voltage is applied to the valve R, and since the valve possesses unilateral conductivity a pulsating direct current flows

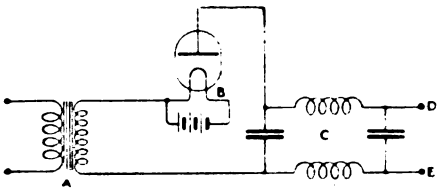

Fig. 3.

into and charges up the first condenser of the smoothing-out device C. This latter arrangement is exactly similar to that described in the last section. The final result is that a comparatively steady voltage is maintained across the terminals D and E.

Practical points to note are that the filament battery of the rectifier valve is directly connected to one terminal of the high-voltage winding of the transformer, and must therefore under no circumstances be touched while the circuit is in operation. Also it should be noted that when the transformer primary is switched off the condensers of the smoothing-out device remain charged, and none of the transmitting apparatus should be handled until these condensers have been discharged by short-circuiting. A special short-circuiting strap consisting of a piece of copper wire mounted in an insulating handle should be kept at hand for this purpose. The valve used must be pumped to a very high vacuum. Any residual gas will be at once evident by the appearance of a blue glow. In the event of a valve showing any signs of blue glow, it should at once be returned to the makers as a rapid disintegration of the filament will set in, resulting in a short life. The rectifier filaments of high-power valve transmitters are generally fed with alternating current from a small highly-insulated transformer thereby avoiding the necessity for any special battery. It is very unlikely that the amateur will be permitted to transmit sufficient power to warrant the use of this transformer, and we do not propose to describe it in these columns.

SOME OF THE CONTENTS OF THE JANUARY NUMBER

Construction of Amateur Wireless Apparatus.

By an Expert Professional.

An Experimental Station.

A detailed, practical description of a very ingenious Sending and Receiving Station.

How Aircraft are Navigated by Wireless.

Notes on the Physics of the Thermionic Valve.

And other Articles of Interest to Amateurs.

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Questions and Answers

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless telegraphy. Readers should comply with the following rules:* (1) *Questions should be numbered and written on one side of the paper only, and should not exceed four in number.* (2) *Queries should be clear and concise.* (3) *Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before.* **(4) The Editor cannot undertake to reply to queries by post.** (5) *All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or if so desired, under a "nom-de-plume."* **(6) Readers desirous of knowing the conditions of service, etc., for wireless operators, will save time by writing direct to the various firms employing operators.**

L.H.G.M. (Holland).—Condensers are still used in connection with telephone transformers. The condenser is connected as in your Fig. 2, that is, across the primary winding of the telephone transformer.

The condenser is often made adjustable in steps in order to tune the primary circuit of the telephone transformer to the note frequency of any particular station.

AMPLIFIER (Hertfordshire).—(1) We do not think that the accumulation of moisture on the diaphragms of the telephones would account for the "fading away of signals" you have noticed. Unfortunately you give us no information of what detector you were using or whether you were travelling away from the station you were receiving. It may possibly be caused by atmospheric conditions or the land between the transmitting station and your receiver. The latter cause is the most probable.

Some time ago we had occasion to take down messages from an aeroplane, and noticed a similar effect, the strength of the signals then rising to a normal again. Afterwards when comparing notes with the observer it was found that the fading away was due to absorption by a cloud through which they flew.

(2) We do not think so. Mr. Bangay's book, however, covers a considerable amount of the subject.

(3) No. Valves do not amplify atmospherics to quite the same extent as they do signals, but atmospherics are of course amplified, especially with receivers using note-frequency amplification.

F.A.W. (Parkeston).—Asks for a diagram of connections for a three-electrode valve for receiving spark and C.W. Stations.

Since our correspondent is only just starting to use a three-electrode valve we would like to refer him to a series of articles headed "Construction of Amateur Wireless Apparatus" now appearing in the WIRELESS WORLD. In the October number will be found diagrams of connections of a three-electrode valve, when used for different purposes. Fig. 3 shows the connections of the valve when used as a rectifier of received oscillations.

In this particular diagram the connections show a "two-circuit" receiver, but the aerial can be connected to the grid (that is the dotted line) of the valve, and the earth connected to the lower end of the grid inductance. If these connections are used the circuit is then a single circuit receiver. Either of these two methods of connecting the valve can be used for reception of spark signals. For the reception of C.W. Stations, however, a small addition must be made to the plate circuit. A coil somewhat smaller in diameter than the grid inductance coil is inserted in the plate circuit of the valve. Break the lead between the H.T. Battery and the plate, and insert the coil between the two points.

The coil is so arranged that it can slide up to and, if necessary, into the lower end of the grid inductance coil.

The coil or "reaction coil" as it is termed can be made by winding about 20 turns of No. 30 to 36 D.S.C. wire on an ebonite former.

If the correct end of the reaction coil is connected to the plate, then the valve circuit will oscillate when the coil is just in the grid inductance coil. It is easy to tell when the valve is oscillating as the musical note of a spark transmitting station will be turned into a harsh rough sound. If this does not occur reverse the connections of the reaction coil.

A valve arranged with a reaction coil is suitable for the reception of both spark and C.W. Stations.

For the reception of spark stations the reaction coil should be so adjusted that the valve is nearly oscillating. This is the point of maximum magnification.

For the reception of C.W. Station adjust the position of the reaction coil until the valve oscillates.

Ques. 3. Nauen's wavelength is 5,500 metres. (Spark) Carnarvon's wavelength is about 14,000 metres.

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Ques. 4.—Can a valve be used as an amplifier in conjunction with a type 31 Marconi Crystal Receiver?

Yes. It is better to amplify first with the valve and then to rectify the magnified received oscillations with the crystal.

E.T. (Seaham Harbour).—The wire generally used to wind potentiometers is about No. 36. It does not matter what size wire is used as long as a resistance of about 400 w. can be obtained on a former preferably about 6" long. If a thicker wire is used there will of course have to be more turns of wire and it is merely a matter of convenience as to the length of the potentiometer.

We presume E.T. wishes to use the potentiometer in conjunction with a crystal rectifier. If this is so, we would refer him to the September issue of the WIRELESS WORLD, page 353, where he will find a diagram of connections.

The lower diagram on page 353 shows the connections of a double slider inductance. Incidentally, the numbers of these two diagrams should be transposed.

"CONSTANT READER" (Co. Armagh).—(1) We are not aware of any book where collected information on the design of such apparatus is available. The most useful would probably be "Experimental Wireless Stations" by P. Edelman, or "Amateur Wireless Telegraph Designs," by Alfree, although these do not contain by any means all the information you desire.

The bulk of such design information is generally to be found scattered through the pages of various periodicals—such as the *Proceedings of the Institute of Radio Engineers* New York; the *Electrician;* the *Electrical World;* the *Model Engineer,* and similar publications.

C.W.H. (Chester).—To give any sort of estimate of the approximate wavelength of your aerial would be a very difficult matter, owing to the complicated way you propose setting it out. Why not use one of the standard aerial systems either an inverted "L," a "T," a plain umbrella, or simply a straight wire as high as possible at one end and the other end being fixed near the ground.

We do not know if you think your aerial system has any special advantages except on the score of small height but we think the radiation from it would be extremely poor and we do not think the Post Office will let you transmit with "plain aerial."

There is no fee for matters dealt with in this section.

G.P.K. (Leeds).—1. We regret that we do not know of any book dealing with the design and construction of telephone transformers. (2).—A high tension battery made up of test tubes with a strip of copper and a strip of zinc in each test tube would be quite satisfactory for demonstration purposes in a laboratory as it can be taken down and cleaned immediately after use. If kept assembled means would have to be adopted to cover the tubes in, otherwise the electrolyte would soon evaporate. Also it would be advantageous to place strips of glass between the copper and zinc strips in order to prevent a short circuit in the cell. (3). With reference to the "earthing" of your apparatus we must remind you that we do *not* advocate the use of water pipes for this purpose. It is a very bad practice, to say the least. We do not think you will have much difficulty with your "earth" if you use the wire fencing. Can you spread this on the ground under your aerial? The netting will then act as a counter-balancing capacity. This will not alter your tuning.

"NEWCASTLE" (Newcastle).—(1) The current passing through a selenium cell will depend on the resistance of the cell at the time of exposure to light, and will of course vary according to the brilliancy of the light. To obtain this current a local battery of not more than about 2 volts is used. To use a greater voltage would render the cell liable to damage. (2) The resistance of a selenium cell may be anything beween 100 and 1,000,000 w. so that the current due to a 2V. cell would be very small. Taking, as an example, the resistance of a cell in the dark, as 10,000 w. we have a current of 0·0002 amps. On exposure to light the resistance falls to 2,000 w. we then have a current of 0·001 amps. It will be seen, therefore, that the relay will have to be very sensitive to work on this current.

(We regret we are compelled to hold over a number of replies.)

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Company Notes

MARCONI'S WIRELESS TELEGRAPH COMPANY, LIMITED

EXTRAORDINARY GENERAL MEETING

CONSIDERABLE PROGRESS IN WIRELESS TELEPHONY.

An EXTRAORDINARY GENERAL MEETING of Marconi's Wireless Telegraph Company (Limited) was held on Thursday, November 13th, at the Connaught Rooms, Great Queen-street, Kingsway, W.C., to consider a resolution authorizing the increase of the capital to £3,000,000. Mr. Godfrey C. Isaacs (Deputy Chairman and Managing Director) presided, and there was a large attendance of shareholders.

The Secretary (Mr. H. W. Corby, F.C.I.S.) read the notice convening the meeting.

The Chairman said:—Ladies and gentlemen, we have convened this meeting, as our circular has informed you, for the purpose of considering a resolution which is set out upon the notice convening the meeting, authorizing the increase of the capital of the company to £3,000,000 sterling by the creation of 1,500,000 additional Ordinary shares. When I last had the pleasure of addressing you, on August 7th, I then told you that I fully contemplated the necessity of my calling you together again some time in the autumn to consider an increase of capital. On that occasion I gave you a great deal of information respecting the developments of the company's business, which alone might have gone a long way towards justifying the resolution which we proposed to submit to you. Much, however, has occurred since that date, and arrangements of great magnitude and importance have been made for which considerable additional capital will be required. Our commitments on business and agreements already entered into in the East are very considerable, these alone requiring in the neighbourhood of one million sterling; and the arrangements entered into in respect of developments in South America will call for another million sterling. These are only two instances, but there are many more which entail the provision of smaller sums which in the aggregate represent a much bigger total. But apart from engagements to which we are already committed we have considerable other business under negotiation, and I think we should fail in our duty to you if our business were in any way prejudiced in consequence of our not having foreseen in good time the capital expenditure for which the probabilities of the future would call.

LESSONS OF THE WAR: FOREIGN GOVERNMENTS AND WIRELESS STATIONS.

There is no doubt that the war has brought home to every Government and to the peoples of every country the great necessity of wireless telegraph services for all purposes. Wireless telegraphy before the war was regarded, I think, by most as something which had a utility and was promising, and it was turned to account in a comparatively small degree in many countries largely as a result of the individual efforts of private enterprise. The war, however, clearly demonstrated to everybody that wireless telegraphy was no longer a toy, but had become a really reliable means of telegraphic communication. Consequently so soon as the Armistice was declared and the possibility of supply of material and construction of stations came into reasonable prospect of execution, nearly every Government turned its mind seriously to the problem of how best this new art could serve them. Germany, it will be remembered, had to rely entirely upon wireless telegraphy for external communication during the war, and the absence of all cables did not prevent their conducting very efficient telegraph services with countries as distant as the United States of America, and during the early part of hostilities with colonies at far greater distances.

France has lost no time in making provision for a chain of stations which will enable her to have thorough communication with all her colonies, no matter how far distant, and with all other parts of the world. A number of stations are being erected by her both in Europe and abroad for these purposes. The French company, in which we are substantially interested, is engaged in constructing these stations, and by reason of our close association they are able to give the benefit, not only of their own latest inventions and patents, but also of all those belonging to this company. Italy, Spain, Portugal, Belgium, Holland, Denmark, Sweden, and the new Balkan Republics are all considering or negotiating for the erection of long-distance independent wireless communication, and stations of the latest type will be erected in each of these countries.

In North America a number of high-power stations have been erected and a large number of additional stations are about to be built by the new American Radio Corporation,

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about which I will say a word or two later. In South America we are building stations and there is considerable further work in prospect. The East I have already mentioned, but in addition to the commitments to which I have referred, negotiations have recently been opened for additional work of considerable importance. The time is perhaps not far distant when much of our attention must be turned to Russia.

COMMERCE AND TELEGRAPHIC DELAYS.

So far as this country is concerned, and its Dominions and Dependencies across the seas, as far as I know, beyond the announcement which has already been made by His Majesty's Postmaster-General as to the stations in England and Egypt, no decision has been taken. I had hoped when I addressed you last that ere this there might have been a defined policy and that the large sum of money which had been paid to us in damages and which I proposed not to touch would have been turned to good account for the nation. (Hear, hear.) This money could have been so usefully expended in helping towards the provision of better telegraphic communication with the Dominions and Possessions beyond the seas. Every one of us has been urged to do, and is doing, I hope, his utmost to develop the trade of the country, and there is little doubt, in my opinion, that only substantial increase in our exports will have any important bearing upon the amelioration of exchanges and reduction in the cost of living. But we are at the present moment and in the future shall be yet more dependent upon quick communication to hold our own in the world's commercial competition. But what is the position today? We all find ourselves hampered in all our business negotiations through the terrible delays in communicating abroad. To obtain a telegraphic reply from the East, one must wait two or three weeks. And even with the Continent, I am still being informed by my correspondents that it is almost useless to send telegrams, for invariably they arrive after the confirmatory letter. It is true a six-hour wireless service is being conducted by the Post Office with Holland and Denmark, but either the traffic is such that the time allotted for the service is insufficient, or the stations which are being used for the purpose are of an old type and built for other purposes, for there has been no noticeable improvement in the expedition of the telegraph services.

WIRELESS TELEPHONY.

As regards the Imperial Chain of Stations something, I believe, is being done in continuing the construction of the English and Egyptian stations, but I cannot believe that the installation of an obsolete system will be persisted in. (Hear, hear.) I feel confident that we shall not much longer lag behind. We must have an improved telephone service, as we must have the best possible wireless service. I feel sure that this country will soon wake up to the necessities of the times and eventually will demand, and the Government will recognize that it requires, the latest and best possible wireless chain of stations. (Hear, hear.) When that day comes, and it may be very soon, we propose to be ready.

I have so far spoken to you of wireless telegraphy, but there is another field of development which will call for very considerable resources, and that is wireless telephony. Considerable progress has been made and is being made daily in this new art, and a great future lies before it. It is already assuming a practical commercial shape and gives promise of an immediate extension to our business throughout the world.

THE COMPANY'S FINANCIAL RESOURCES.

I have probably said sufficient to justify the resolution which we propose to put to you. That we are in a very sound financial position you know from our last balance-sheet. Our reserve account then stood at £1,100,000; we have since received £590,000, the amount of the award, and we have sold the whole of our shareholding in the American Marconi Company, which will add a further substantial sum to our resources. But after very full and careful consideration your board is of opinion that considerable additional capital will be required in order that your company shall continue its progress and have the means of turning to full advantage the opportunities of the commercial developments of its business which peace will bring to us after five years of work devoted to purposes of war.

SALE OF THE AMERICAN MARCONI SHARES.

I have mentioned the sale of our American shares, but I think it right to tell shareholders that the arrangements we have made with the General Electric Company of New York and the American Radio Corporation are of such importance that we feel satisfied that besides obtaining a reasonable price for our interest in the American company, we have secured as further consideration advantages of far-reaching importance which will cement and strengthen our world-wide organization, the fruits of which will ripen, we hope, in the near future.

Whilst upon this subject I would like to say for shareholders' information that the circular which was issued by the American Marconi Company, full and explicit as it was, did not, in my opinion, make clear to our many shareholders, who are also shareholders in the American company, what they are receiving in exchange for their shares. I had understood that shareholders would receive one Preference and one Ordinary share for every share held, and that these shares will be marketable and very soon command a good premium, but besides this there were substantial assets remaining to the American company which comprised very considerable amounts payable by the American Government and large sums payable by others in respect of the use on a very large scale of the American company's patents for many

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years. These amounts have increased as years have gone by, partly because decisions of the Courts were required—(these have now been obtained)—and in part because accounts could not be adjusted during the war. These sums have therefore accumulated and must represent a very considerable total. I am glad to say that my views have been confirmed within the last 48 hours. I have received a letter informing me that it is agreed that this matter was not made sufficiently clear by the circular. It is proposed that a scrip certificate shall be issued to every shareholder in the American Marconi Company after, or at the time of, his exchanging his American shares for the Radio Corporation shares, which scrip certificate will entitle him, first, to the dividend which is to be declared shortly, and, secondly, to his quota of the moneys which have to be received from time to time and as and when they are received. (Hear, hear.)

A Reply to Criticism.

Before formally putting to you the resolution there is one word I would like to say in reply to some criticisms which have been addressed to us from our friends in Ireland, arising, I think, from some misunderstanding. It is thought that there is an inconsistency in the wording of that resolution and the statement in our circular that an issue will be made as soon as possible after the confirmatory meeting if the resolution be approved, "on favourable terms to shareholders," whereas the resolution provides that the increase of capital shall be issued to "such persons, firms, or corporations as the directors think fit." This seems to have been understood to mean that the shareholders would not have the opportunity of subscribing for the shares. This is not either the intention or the meaning of the resolution, which is framed in the usual form and, I believe, is the exact wording of other resolutions which we have submitted to you on previous occasions. Shareholders may rest quite confident that their interests alone will be studied by the directors, and the shares will be offered to them on the most favourable terms consistent with the interests and requirements of the company. (Hear, hear.) I now beg to move "that the capital of the company be increased by the creation of £1,500,000 new Ordinary shares of £1 each, to be issued to such persons, firms, or corporations, at such times and at such price or prices, and upon such terms and conditions as the directors think fit, such shares to rank for dividends declared in respect of the period commencing the 1st day of January, 1920, but in all other respects to rank *pari passu* with the existing £1,250,000 Ordinary shares of £1 each." (Cheers.)

Mr. Sidney St. J. Steadman seconded the resolution.

Shareholders' Questions.

Captain Bernard Daly (Dublin) said that he had been asked by a number of shareholders to inquire what their position would be in any issue of the new capital. There was a strong feeling that the present Ordinary shareholders should be entitled to an allotment in proportion to their holdings in priority to any corporation or outsider. (Hear, hear.)

Mr. George L. Moore observed that, as the previous speaker had referred to the Ordinary shareholders, he would like the chairman to define the position of the Preference shareholders, of whom he was one. He took it, subject to the chairman's correction, that the Preference shareholders, after payment of the Ordinary dividend, were entitled to rank in all respects with the Ordinary shareholders. Continuing, Mr. Moore said that they had all listened with very great pleasure to the speech from the chair, though not with any greater pleasure perhaps than they expected, as Mr. Godfrey Isaacs always gave them a lucid and interesting address. His only wonder was whether the proposed increase of the capital to £3,000,000 was sufficient in view of the handsome terms in which the chairman had spoken of the company's prospects in all parts of the world. But no doubt the directors had well considered the matter, and had decided, what with reserves and award money, that the increase now recommended was sufficient. He had nothing more to say except to compliment the chairman and directors on the position of affairs, and he was sure they considered themselves fortunate in having Mr. Godfrey Isaacs occupying the position he did. (Hear, hear.) They all knew that that gentleman came of a very clever and wide-awake family. (Hear, hear.) The Marconi Wireless Company was a live concern and would keep going ahead in spite of all obstacles—Government or otherwise. (Cheers.)

Mr. S. H. Roche said that he had come to the meeting on account of statements contained in the circular sent out to the shareholders, and to ask how the holders of Ordinary shares were going to be treated when the new capital was issued.

Chairman's Statement as to New Issues.

The Chairman—Ladies and gentlemen, the shareholder from Ireland has put to me a question which a shareholder wrote to me about and also wrote several letters to Irish and English newspapers. I do not quite know what the directors have done to deserve the criticism which he suggested in his letter. There is nothing whatsoever, so far as I can gauge, that justifies any suggestion that the directors contemplate doing otherwise than they have always done in the whole history of the company—that is, that anyone who is not a shareholder should get any advantage that a shareholder should not have first of all. (Hear, hear.) That has not been our practice; we have never done anything of the kind, and in future we do not intend to do it. I thought I had made that perfectly clear in my reply to the Irish shareholders. I thought

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I had made it perfectly plain that nothing of the sort was intended by the circular nor would be in any way adopted by the board. (Hear, hear.) I think the statement itself was perfectly clear. The words of the resolution, that the directors shall have power to issue shares "to such persons, firms, or corporations" is quite the ordinary form, but it seems to have been responsible for giving rise to this misapprehension. But I think the Irish shareholders forget, and perhaps others forget, that besides individual shareholders in the company, there are firms and corporations who may be shareholders, and in taking power in the resolution to allot shares you will agree that we must take power to allot shares to such firms and corporations, as well as to personal shareholders. (Hear, hear.) Perhaps that will be deemed a full and sufficient reply to the question which has been put to me about the Ordinary shares. With regard to the Preference shares, Mr. Moore has correctly understood the position except in so far as the first preferential right of dividend is concerned. It is after the ordinary shareholders have received 10 per cent. that the Preference shareholders rank in all respects equally with the Ordinary shareholders.

Future Proposal for Conversion of the Preference Shares.

Now, ladies and gentlemen, it had been my intention to suggest to you at this meeting that we should get rid of our Preference shares—that we should find means of converting them into Ordinary shares. To-day, with the capital standing at what it does, and with the assets being what they are, it seems to me there is no reason to have 250,000 Preference shares, especially if we are going to have 2,750,000 Ordinary shares. I should like to see those Preference shares converted into Ordinary shares, and I should have proposed it to you to-day, but for the fact that the matter presents some difficulty and requires some time before it can be put before you—it also, I think, requires the sanction of the Court—and there was not time without delaying the meeting, which I did not want to do; but at a future time I propose submitting some such proposal.

A Shareholder said he should like some information with regard to the large sum owing by the Government to the company for work during the war. It seemed to be rather "hanging fire" for no particularly sound reason. He would like to know if there was any prospect of an early payment, and what addition it would make to their funds.

The Company's Claims Against Government Departments.

The Chairman: With regard to the sums due to the company from the Admiralty, the War Office, and the Air Ministry, there is unfortunately a reason for the delay in their payment. One important matter which will govern very largely the amounts which will be due to us must be settled by arbitration—it has been agreed throughout that it should be settled by arbitration—and the only reason why that has not yet been dealt with is that Lord Moulton, who it was agreed long ago should act as arbitrator, has had his time so much taken up by other public matters of importance. However, I believe Lord Moulton is now fixing a date, which will not be very far distant when this arbitration will be heard, and thereafter I hope we shall be able to make progress with all these matters with each of the respective Government Departments. As to the payment of services rendered during the war, I am sorry to say that we have not progressed. I think I told you at the last meeting that unfortunately we had been unable to get any reasonable offer in settlement, and had had finally to have recourse to another Petition of Right. Well, we have been awaiting a communication from the Post Office in respect of that matter, and all I can say is that I do very sincerely hope that that communication is going to be of such a nature that, with the great desire we have to avoid anything in the nature of unpleasantness with any Government Department, we may be justified in agreeing to it. You may rest assured, so far as the board is concerned, and I think it will be your wish also, that even at a sacrifice we would settle the matter sooner than be forced into a Court of law again. That is the view I hold, and I believe it is the view of my colleagues and I hope yours too. (Hear, hear.) I trust we shall not be called upon to make too big a sacrifice, but the matter must be settled; it has to be settled in our interests and in the country's interests.

Mr. A. C. Clarke asked if there were any reason why the shareholders should not on that occasion be informed of the terms of the proposed new issue.

The Chairman: I think for the best of all reasons—we have not yet made up our minds.

Mrs. Barbara Baynton said that several widowed ladies who were shareholders would like to thank Mr. Godfrey Isaacs for the care and attention with which he had handled the business of this company. Through both "good and evil report" he had stuck to it, and she wished to express her admiration and deep gratitude on behalf of herself and others.

Mr. Charles Terry said that after the tremendous services which the company had rendered during the war he thought it was a disgrace that the Government had not settled their claim. (Hear, hear.)

The resolution was then put to the meeting and carried unanimously.

The Chairman: We have received proxies from 3,091 shareholders endorsing and approving this resolution. Ladies and gentlemen, I thank you, and the lady shareholder who was good enough to say a few words of appreciation of my work. (Hear, hear.) We like to hear these things sometimes, and more particularly when they come from the fair sex. (Hear, hear, and laughter.) That concludes our meeting.

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AMALGAMATED WIRELESS (AUSTRALASIA) LIMITED.

DIRECTORS' REPORT.

Presented to the Shareholders at the Twelfth Half-Yearly Ordinary General Meeting, held at the Registered Office of the Company, "Wireless House," 97, Clarence Street, Sydney, on Friday, August 29th, 1919, at 12.30 p.m.

Your Directors have pleasure in submitting herewith the Balance Sheet and Profit and Loss Account for the six months ended June 30th, 1919.

The net profits of the business for the half-year amount to £4,207 7s. 3d., which, together with £743 2s. 5d. brought forward from last account, leaves a balance of £4,950 9s. 8d. to the credit of the Profit and Loss Account.

From the above amount, which is available for distribution, your Directors propose to pay a dividend for the half-year at the rate of 5 per cent. per annum. This will absorb £3,500, and will leave a balance of £1,450 9s. 8d. to be carried forward to next account.

The several departments of your business are steadily expanding, although in common with all other businesses the problems of transition from a war period to peace are being experienced.

It is again possible to send wireless messages to ships at sea from any ordinary telegraph office on shore, but the Australasian passenger services are not yet fully restored.

Your Directors have reason to suppose that future legislation following the lines of that recently passed in the United Kingdom will make it necessary to instal wireless apparatus in all sea-going vessels of 1,600 tons and upwards.

It is hoped that the Company will shortly be able to proceed with the development in Australia and New Zealand of the Relay Automatic Telephone System which has recently been installed throughout Australia House and other important buildings in the United Kingdom, and for which the Company holds a sole agency.

The question of direct wireless services between Australia and countries overseas is being considered by your Directors in conjunction with the Marconi Company. From expert advice received and by actual tests carried out by the Managing Director, your Directors are satisfied that such services can be successfully established if they are conducted on proper lines and so long as no attempt is made to combine a commercial service with a naval service. The requirements and the organisation of the two are entirely different, and any attempt to combine them would lead to inefficiency in one or both services.

Several additional wireless patents have been added to those covered by the Company's sole and exclusive licences.

In view of the declared policy of the Federal Government to protect Australian industries, your Directors expect that it will be possible to continue and increase the manufacture of many classes of electrical apparatus in your factory, which is now one of the best equipped private electrical works in the Commonwealth.

In view of the expansion of the Company's work, your Directors have under consideration an application to the Commonwealth Treasurer for permission to increase the capital of the Company. Any proposal of this nature, when matured, will of course be submitted for the approval of the Shareholders in the prescribed manner.

Your Directors propose submitting a Special Resolution immediately after the Ordinary Meeting, substituting One Annual General Meeting for the Half-Yearly Meetings, but the authority given in Art. 129, for the payment of half-yearly dividends, will remain.

Dividend cheques will be available on the 20th instant, immediately the dividend is passed.

THOMAS HUGHES, Chairman.

ERNEST T. FISK, Managing Director.

Sydney, August 19th, 1919.

CHAIRMAN'S ADDRESS.

In moving the adoption of the Report and Balance Sheet, the Chairman, the Hon. Sir Thomas Hughes, M.L.C., said: "I would invite your attention to the fact that the profit for the period is greater by £189 than in the past half-year and by £556 for the corresponding period of last year. The increased amounts shown for sundry debtors and creditors and Bank overdraft arise out of the increasing business."

"An additional number of vessels are being supplied with the Company's service and apparatus and it will no doubt interest you to learn that the Company is now conducting wireless services on board a considerable number of British vessels that are trading in all parts of the world and by arrangement with associated companies throughout the British

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Empire and in Allied countries, we are able to provide for the shipowners a uniform organisation and apparatus of a standard pattern with that used in more than 3,000 British merchant vessels at the present day." . . . . . "Ships carrying our apparatus and our operators can go into any of the principal ports of the world and find a depot and an inspector who is able to direct and assist the operator in all branches of his work, who understands the apparatus and is able to effect repairs or supply standard spare parts upon the shortest notice."

The Chairman went on to say that a merchant vessel at sea is through the organisations of the Company linked by its wireless with all the inland telegraph and cable lines of the world. He mentioned that the Company is expending considerable sums in the development of wireless telephony which will prove to be very valuable and particularly in Australia where aviation and wireless communication will be amongst the greatest factors in developing the vast inland territory and destroying its isolation. He said further that as a result of the successful experiments whereby wireless messages were received in Sydney direct from the Marconi Company's Trans-Atlantic station in Wales an offer had been made to provide a permanent direct commercial service between England and Australia, and added that all classes of messages would at first be forwarded by the wireless service at one-third less than the existing cable rates, and that as the number of daily messages increased beyond certain defined stages this rate would be proportionately reduced.

The Chairman then dealt with the question of obtaining a licence to work and operate wireless stations, and pointed out that negotiations for this licence were being followed up, and expressed the hope of the Directors that the Government would decide the matter without undue delay. He further urged the necessity for keeping the country's commercial wireless service quite distinct from any naval service, giving his opinion that any attempt to combine the two would destroy all possibility of efficiency on either side.

The Chairman then went on to say "we believe it has even been suggested by some of the opponents of this scheme that no company should be granted a monopoly of overseas communication, and it is an astonishing fact that such suggestions are seriously raised because there is nothing under the Wireless Telegraph Act to prevent similar licences being given other companies who can produce a workable system and who are sufficiently enterprising and courageous to undertake so great a scheme." . . . . . .

"All we have asked for is a licence to erect stations and work them under the provisions of the Act which gives the Government full control over such stations and enables it to close them or take them over not only upon the actual outbreak of war, but at any time of threatened public danger if it were considered necessary to do so."

The Chairman concluded his remarks with observations upon the manufacturing extensions of the Company's business, pointing out that it had one of the best equipped electrical workshops in the State, and that the general electrical section of the manufacturing business is now conducted by the Australectric Company which the Directors have registered in the Company's name for that purpose. The Australectric Company also looks after the Agency for the Relay Automatic Telephone System for which the Company has both the selling and manufacturing rights in Australia and New Zealand.

"At the present time the Company gives employment to a staff of 250 and is paying no less than £40,000 annually in salaries and wages."

EXTRAORDINARY GENERAL MEETING.

At an Extraordinary General Meeting held immediately on the close of the Ordinary General Meeting the subjoined resolutions were unanimously carried:—

RESOLUTIONS.

1. That the Capital of the Company be increased to £200,000 by the creation of 60,000 new shares of £1 each.

2. That the Articles of Association of the Company be altered as follows:—

   (a) By omitting the word "twice" in the first line of Article 55 and substituting in lieu thereof the word "once" and by omitting the words "months of February and August" in the fifth line of the same Article and substituting in lieu thereof the words, "month of August."

   (b) By omitting the word "first" in the third line of Article 90.

   (c) By omitting the word "each" in the second line of Article 142 and substituting in lieu thereof the word "the."

   (d) By omitting the word "first" in the sixth line of Article 146.

The effect of the second resolution is to substitute one Annual General Meeting for two Half-Yearly Meetings.

By Order of the Board,

J. F. WILSON, Secretary.

August 20th, 1910.

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Amalgamated Wireless (Australasia) Limited.

BALANCE SHEET as at June 30th, 1919.

LIABILITIES.	£ s. d.	£ s. d.
Capital		140,000 0 0
Bank Overdraft .	13.507 17 10	
Sundry Creditors	20,150 10 3	
		33,658 8 1
Reserve for—		
Patents, Depreciation, and Insurance		31,727 0 2
Profit and Loss Account—		
Balance at Dec. 31st, 1918 ..	4,243 2 5	
Less Dividend for the Half-Year at 5% p.a.	3,500 0 0	
	743 2 5	
Plus Profit for period	4,207 7 3	
		4,950 9 8
		£210,335 17 11

ASSETS.	£ s. d.
Patent Rights	90,000 0 0
Plant, Apparatus, Stock, Stores, Furniture and Fittings	86,553 8 6
Sundry Debtors	23,074 7 4
War Loan Bonds and Inscribed Stock..	10,387 10 0
Branch Bank Balances and Petty Cash	320 12 1
	£210,335 17 11

PROFIT AND LOSS ACCOUNT

For the Six Months ended June 30th, 1919.

1919. June 30.	£ s. d.	1919. June 30.	£ s. d.
To Operating Expenses, Directors' and Auditor's Fees and General Administration Expenses	15,337 4 6	By Gross Profit from Trading, and Revenue from Wireless Stations	22,296 16 11
,, Depreciation	2,752 5 2		
,, Net Profit	4,207 7 3		
	£22,296 16 11		£22,296 16 11

J. F. WILSON, Secretary.
F. W. LARKINS, A.I.I.A., A.C.I.S., Accountant.
THOMAS HUGHES, Chairman of Directors.
ERNEST T. FISK, Managing Director.

I have examined the Books and Vouchers of the Company, and certify that the above Balance Sheet and Profit and Loss Account are a correct statement of the Company's affairs as shown by the books of the Company.

ALEX. JOBSON, F.C.P.A., Auditor

Sydney, August 19th, 1919.

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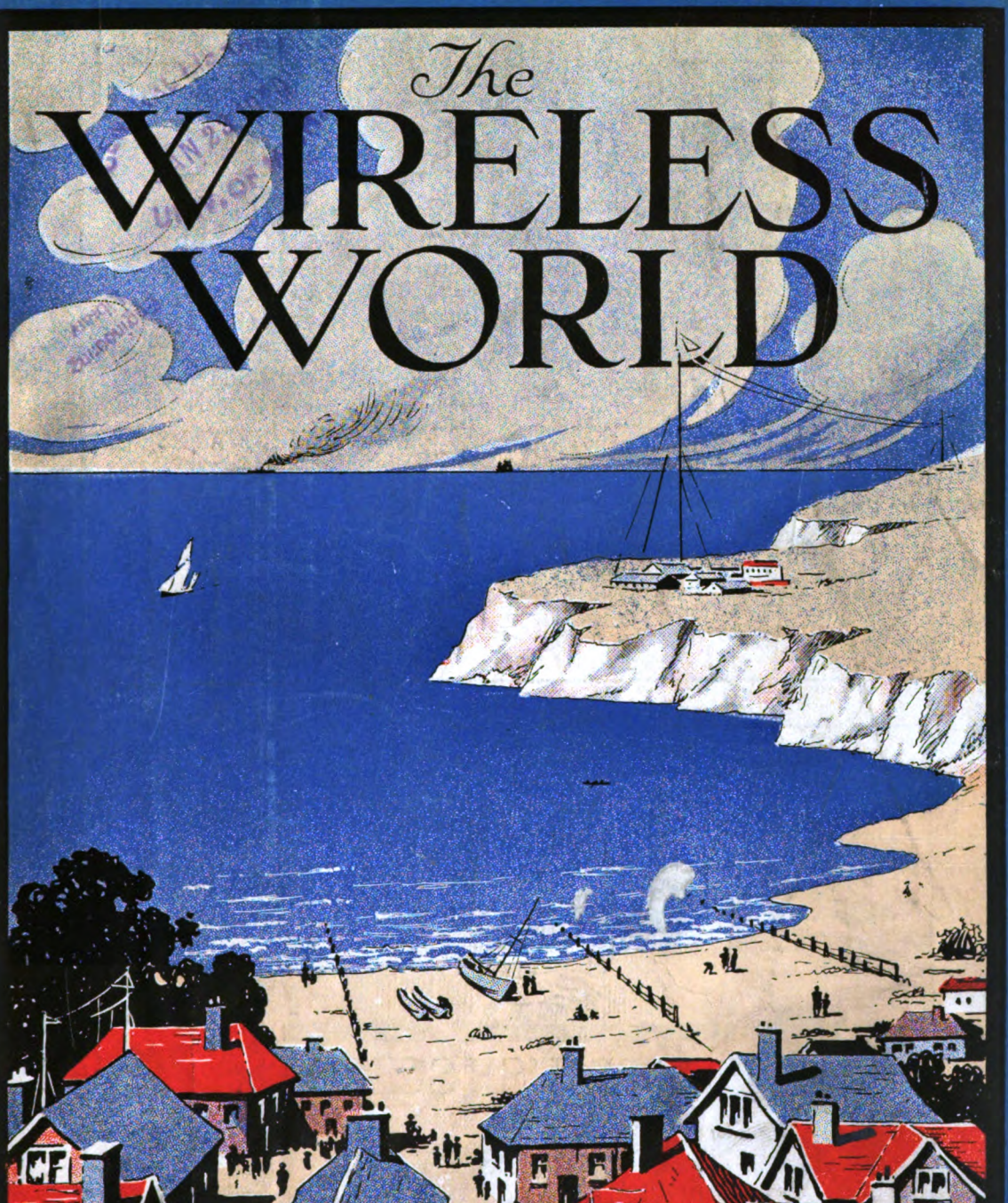
Price 9d. Net. JANUARY, 1920.

The WIRELESS WORLD



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WRITE FOR PROSPECTUS. A. W. WARD (Manager). 'Phone: BRIXTON 215

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THE
WIRELESS WORLD

No. 82
Vol. VII

JANUARY,
1920

Reminiscences of Wireless on the Blimp Patrol.

By MICHAEL B. EGAN.

OF all those wonderful and timely inventions which blossomed so abundantly on the prolific branches of science under the stress of warfare, few exist to-day in which we did not gladly relinquish our ephemeral interest when the joyful news of the armistice dictated our immediate return to the business of peace. Amongst those discoveries which by reason of their exceptional adaptability to the purposes of peace succeeded in retaining the interest of a war-weary people, the marvellous developments which sprang from the sciences of Aeronautics and Wireless Telegraphy and Telephony stand out boldly in the foremost rank. At a time when it was universally realized that the ultimate supremacy of the Allies demanded the immediate and complete suppression of the U-boat campaign, a necessarily captious censorship prevented the general public from fully appreciating the real value of the assistance which our smallest dirigible airships contributed towards the eventual extermination of the elusive Hun. A complete account of the wonderful performances of these little Blimps (technically termed Sea Scouts or S.S. type) and of the astounding utility of the wireless apparatus which they invariably carried would provide a most fascinating volume of romantic endeavour and daring achievement.

The history of the Blimp Patrol, however, has yet to be written, and, in the meantime it will probably be of interest to readers of the WIRELESS WORLD to get a brief impression of the daily life of a wireless operator on one of those secluded Airship Stations which at one time dotted our coasts, from Land's End to Scapa Flow.

That factor which conduced most essentially to the enjoyment of life at an Airship Station was the absence of wet weather. In the winter, even though the prevalence of violent winds

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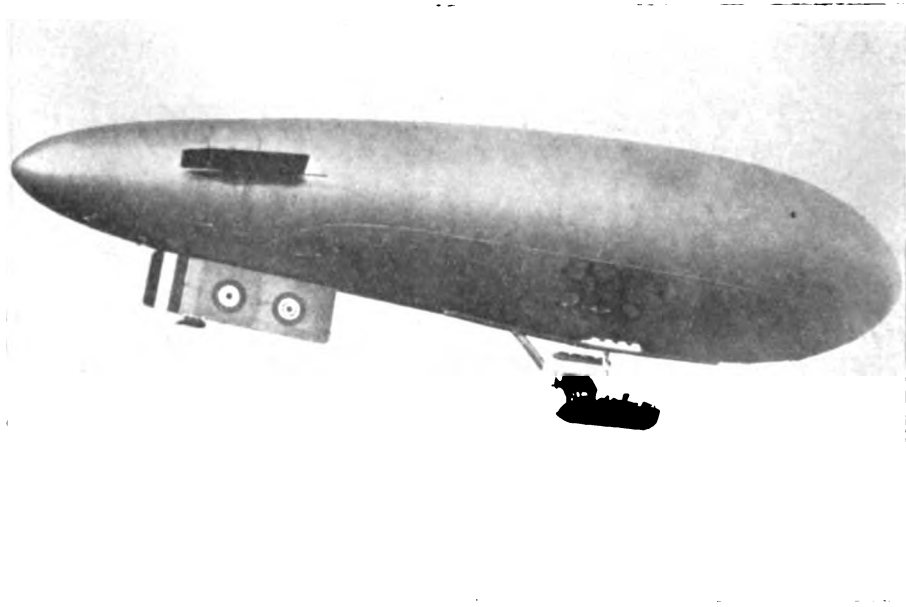

"Z" Type Airship for Anti-Submarine Patrols.
This craft was entirely constructed at Folkestone Airship Station.

might considerably curtail the normal amount of daily flying, so long as the ground remained dry one could with fair comfort roam around from shed to shed and derive a considerable amount of legitimate pleasure from criticising the condition of the wireless gear on all the other ships. Of course, this needed a very fine tact.

Each operator was permanently appointed to one particular ship, and it was an unwritten (though not unvoiced!) law that a visit to a brother operator's ship should at all times be preceded by a polite request. During periods of very heavy rain the approaches to the sheds usually degenerated into treacherous avenues of liquid mud, and at such times it was the custom of all operators to congregate at the Base Wireless Station (usually situated in one corner of the Aerodrome) and teach each other the *correct way* of passing a wireless message from a destroyer to a Coast Station during flight, etc. Needless to say, these discussions invariably invoked pointed and lurid references to a multitude of *wrong* methods!

In good, fine weather life was truly delightful, and the sun-blessed days of summer were wont to tell their joyous tale all too briefly. During the summer months the launching of the early morning patrol constituted the most important event of the day, and the greatest eagerness and enthusiasm was displayed by every officer and man who assisted in getting the ships "pushed out" into the morning blue. Apart from the desire to "get on with the job" which was the motto of the Station, this spirit of cheery enthusiasm between the early hours of 4 a.m. and 5 a.m. was due in some measure to the keen rivalry which existed between all Airship Stations, particularly those within wireless range.

It was considered a matter of supreme importance that the ships from one's own aerodrome should be the *first* to "crash into the atmosphere" each day

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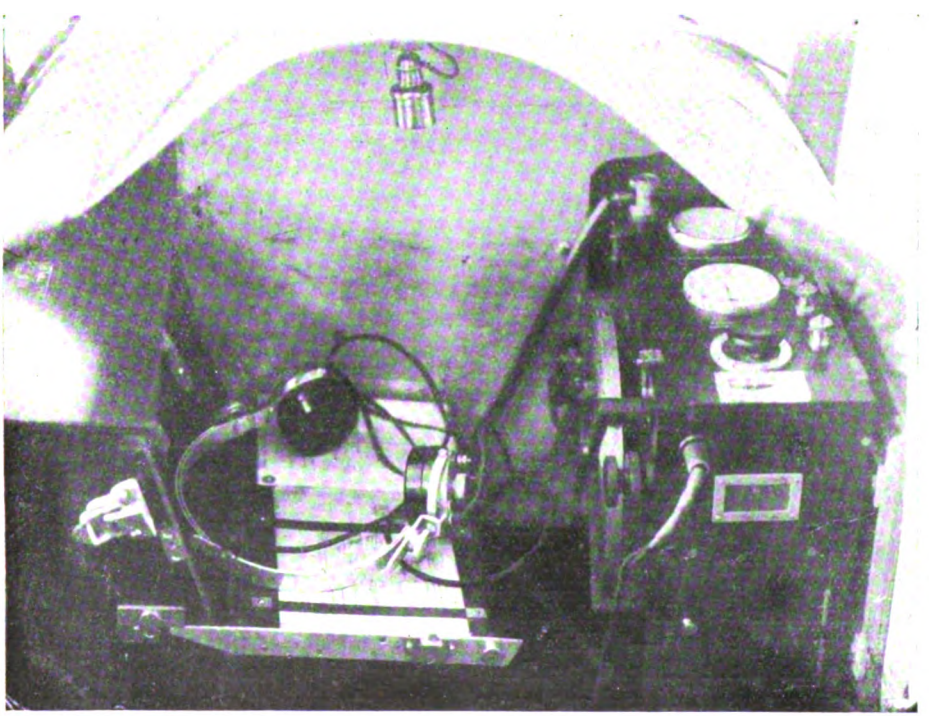
and salute the morning sun, and no effort was spared to achieve this worthy ambition as frequently as possible.

In addition to those operators whose ships were scheduled to fly on the early morning patrol one extra operator was detailed for duty at the Base Wireless Station in order to deal with the periodical reports which the Blimps sent back as they scoured the seas for signs of enemy activity. Every operator on the Station was obliged to officiate as duty operator in turn, and, needless to say, this was a duty whose performance gained scanty favour during bright sunny weather.

This very natural apathy frequently induced the unlucky one to attempt just another little doze after the inevitable bugle had sounded the emphatic order for the evacuation of nice warm bunks.

Thus it came to be considered that the first duty of those operators who were about to go aloft consisted in carefully depositing the unfortunate duty operator at such a distance from his bunk that the mere action of walking back should provide sufficient exertion to dispel all desire to re-enter it! This done, the next few moments were employed in testing one's telephones, donning flying kit and racing across to the sheds to make one last swift overhaul of the wireless installation.

And what a scene of activity and bustle in the shed! Busy hands are quickly unfettering the silent ships by releasing the steel wires which anchor them to the concrete floor. Meantime every part of each ship is being subjected to a swift and thorough overhaul. Solicitous mechanics see to it that there is



The Wireless Cockpit of a Blimp.

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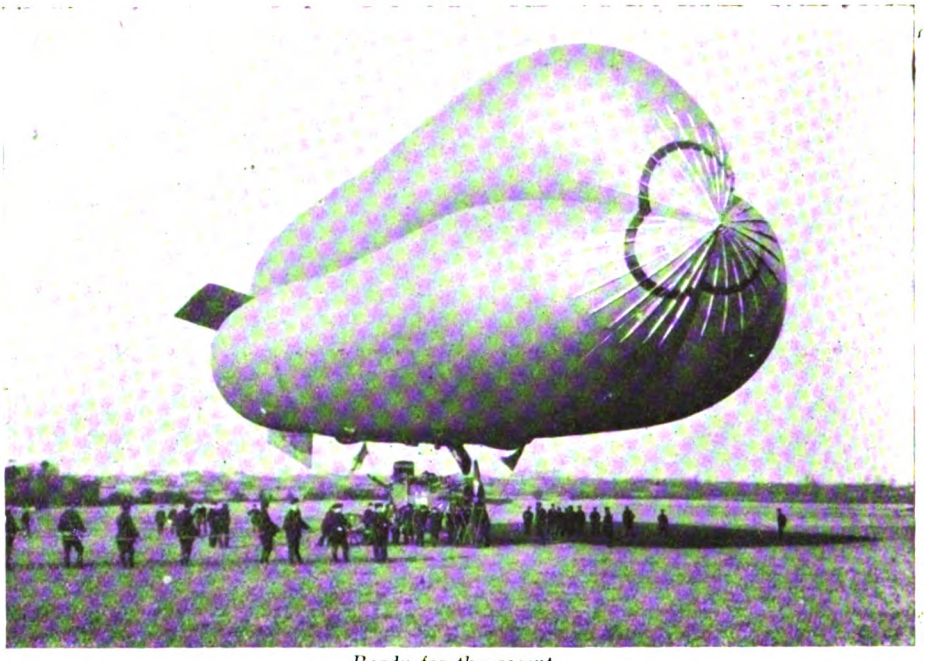

Ready for the ascent.

plenty of petrol and oil and water ballast in the tanks, fitters and riggers insure that all the controls are in thorough working order; an engineer surveys the most vulnerable parts of the engine with an experienced and critical eye; another tests the gas pressures; another checks the ammunition cargo. Presently the massive iron doors in the front of the shed are wheeled apart and the order is given, "All hands on the guys." Careful hands grip the steel guys that stretch down from the envelope of the ship, whilst others apply themselves to the removal of sand-bags from the fuselage in which the pilot is now employed in testing the air and gas pressures. In reply to the second order which follows swiftly upon the first—"Walk ship ahead"—the docile Blimp is "walked" gingerly from the shed and out on to the centre of the aerodrome. Here a halt is called; the propellor is swung and the engine is allowed to run for a few moments whilst the pilot tests its mood.

Then "Climb up, Wireless." Up clambers the wireless operator and forthwith proceeds to adjust his instruments to the approximate valves for the wavelength on which he is about to transmit and receive. Then the final order is given. The pilot waves his hands to the party below as an indication that "all's ready." The officer in charge of the launching party gives the command, "Hands off the guys," and in a moment the silvery Blimp is mounting slowly but steadily into the tranquil blue sky of morning to the accompaniment of the engine's terrific roar. The efficiency of the aerodrome organization ensured that a very brief space of time elapsed between the departure of each ship on the same patrol, and at some stations, where

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a sufficiency of personnel permitted, two or three ships could be launched simultaneously.

At the time to which reference is now made, aircraft wireless had not yet arrived at that stage of its development which was responsible for the supersedence of crystal receivers by the standardised valve receivers and amplifiers of the present day. The valve, of course, was in the test rooms and laboratories on the ground, where scientific experts were employed continuously in chronicling its manifold peculiarities in the attempt to conquer the limitations which retarded its application to the purposes of aircraft wireless. But it had not yet honoured the wireless cockpit of a Blimp with its glowing presence.

In those days the complete wireless installation comprised the R.N.A.S. pattern T C Crystal Receiver which was used in conjunction with the Brown's Relay, and the Sterling Transmitter.

Owing to the extremely sensitive adjustment which was necessary for the efficient working of the Brown's Relay, this instrument was removed as far as possible from the vibration and shock of the engine. It was usually slung on elastic bands inside the tail of the fuselage, and was connected by means of a six-way lead to the Receiver and also to the low-tension batteries in the wireless cockpit which formed an auxiliary portion of its equipment.

To return to the morning Patrol. The first thing to be done when sufficient height had been acquired was to let the aerial out and call up the Base Wireless Station. This practice was adhered to in accordance with Station orders which laid down that all ships should apprise the Base Station of the time at which the patrol was commenced and finished.

Of course, in the majority of cases this was absurdly unnecessary so far as the duty operator was concerned because, at that moment, he was probably gazing enviously at each departing ship, with his nose glued to the window of the wireless cabin, beyond which he could not go owing to the limitations of the telephone leads which effectively tethered him to his instruments! To the operator in the air, however, this practice of signalling the time of departure provided pleasant means of ensuring that his brother operator below was thoroughly and actively awake. It also gave him a welcome opportunity of testing the general efficiency of his own instrument at the outset of the patrol. No matter how much care and attention one might bestow upon one's instruments on the ground, the supreme importance of the part which wireless played in the work on hand made one naturally anxious to ascertain if any hidden fault had developed during the time which elapsed since the previous flight.

In cases where Blimp Airship Stations were situated within a few miles of the coast, the quiet fields and picturesque hamlets of the countryside were soon replaced by the broad desert of green ocean that flashed and danced away to the distant horizon beneath the warm rays of the rising sun. And now the real work of the patrol began. No object in the whole of that watery expanse was too minute or insignificant to escape a thorough scrutiny through the powerful binoculars which formed part of every wireless operator's kit. If any particular craft was too remote to permit of a definite opinion as to her friendly or hostile character the airship's course was altered accordingly until a closer survey established the sincerity of the stranger's intentions. Sometimes it was very difficult to discern objects clearly from any appreciable height above the sea. For example, the periscope of an enemy submarine and its wake did not always

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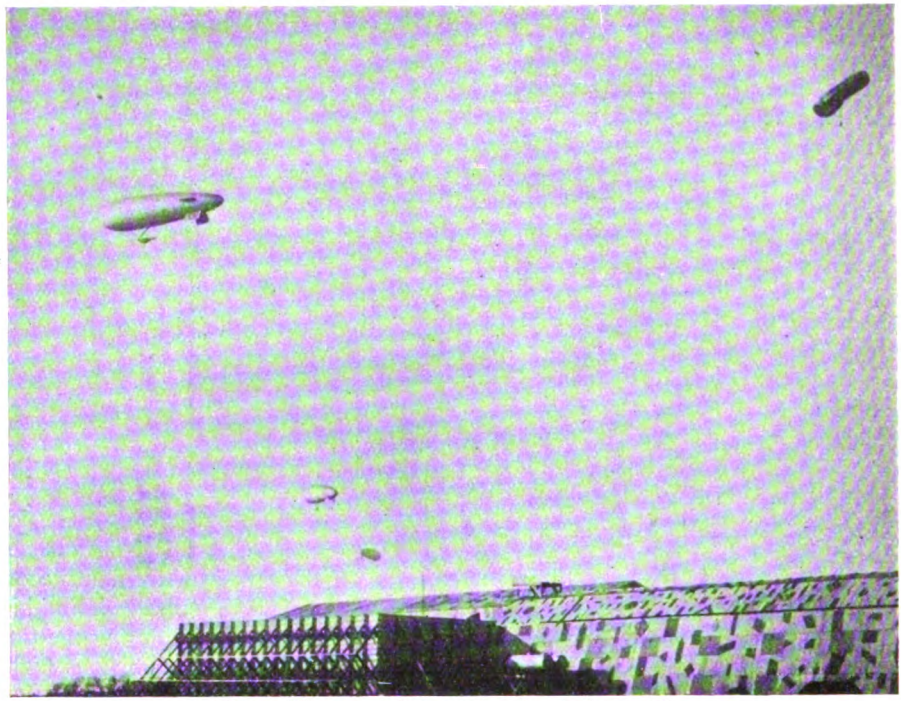

Three Blimps setting out for the day's patrol.

bear a very marked resemblance to the many fine specimens of artistic enterprise that frequently adorned our illustrated periodicals during the war. In a choppy sea the dancing and overlapping waves intermittently obscured the periscope itself and the wake of course hardly existed at all. For the purposes of war, however, doubts and possibilities and uncertainties assumed a degree of importance which was hardly surpassed by that of the realities themselves, and, in consequence had to be reported with equal celerity and precision.

The Admiralty organisation was such that at every moment of the patrol, from sunrise to dusk, the sea scouts could communicate directly with a naval base or with some vessel of the fleet which was engaged on sea patrol in the same area. Thus when enemy or even suspicious craft was observed, a cryptic though comprehensive report was immediately flashed back to the Base Wireless Station and to the nearest naval unit, stating the exact position, course and approximate speed, etc., of the vessel or vessels which had been sighted. In this connection it must be mentioned that our Shore Wireless Directional Stations rendered inestimable assistance. These stations were usually arranged in groups of three throughout different coastal areas. All three stations were fitted with the Bellini-Tosi balanced aerials and radiogoniometer, and one station—the "control" station—was also equipped with transmitting instruments which were particularly adapted for aircraft work. Thus, in the event of being suddenly enveloped in a sea-mist or fog an airship could, by sending a pre-arranged signal, obtain its *exact* position within a very brief space.

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All wireless messages of course were transmitted in secret code and the process of coding and decoding with the promptitude and exactness which wartime operations demanded necessitated considerable practice. The code books were carried in stout covers which were weighted with lead in order that they might be swiftly consigned to the *bottom* of the sea at any moment of emergency.

Needless to say, each day's patrol did not yield signs of those wily denizens of the deep whose activities were a constant menace to our merchant shipping, and every wireless operator on the Blimp Patrol has experienced long and monotonous hours and days which brought nothing of excitement and little of fresh interest.

However, the presence of the enemy was not always the only source of excitement and on days of good visibility the proximity of a sister ship on patrol afforded a welcome opportunity for a little practice in semaphoring and flag-wagging from one ship to another. This could be performed with fair comfort by standing up on one's seat and jamming one foot firmly against the woodwork beneath the cowling which projected over the wireless cockpit. This precaution was necessary in order to maintain one's balance against the air-blast from the propeller.

With reference to this it is interesting to recall that on one or two occasions the ancient art of semaphore was employed to inform one ship that the transmitting apparatus of a sister ship had failed. In this manner the recipient of the message was able to communicate the unfortunate incident to the Base Wireless Station and thus allay the anxiety which would naturally be felt concerning the ship that had probably failed to respond to repeated wireless calls. Such an occurrence was not of course so serious as the sudden failing of the engine. An accident of this nature was necessarily fraught with immediate danger because when deprived of her own power of propulsion an airship is converted into a free balloon without being possessed of the various facilities for descent and landing with which that type of craft is specially equipped. As it was always necessary under such circumstances for the pilot to remain at the controls, it devolved upon the wireless operator to restart the engine, and in those days this could only be accomplished by getting out of the ship and swinging the propellor from behind—it being impossible to swing it from the front whilst the machine was in the air. Not one, or two, but several operators have had the experience of obeying that cryptic summons: "Get out and swing." This was performed by climbing out on to the forward part of the undercarriage and placing one foot broadly across the left-hand skid whilst the right leg was twisted around a stout strut that sloped up to the fuselage. The right foot was jammed tightly against a cross-strut connecting both sides of the undercarriage. If possessed of a strong left arm the right hand might be employed to lend further stability to one's position by grasping one of the engine bearers. This, however, was a somewhat rare feat and the swinging of a propellor under such circumstances was usually accomplished by *leaning* against the engine bearers and utilizing both hands.

In addition to those duties which involved complete and individual responsibility for the operation and maintenance of the wireless installation, the qualifications of a Blimp wireless operator also included a thorough practical knowledge of aerial gunnery, map-reading and map-drawing, aerial photography bomb-dropping, and visual signalling in all its forms.

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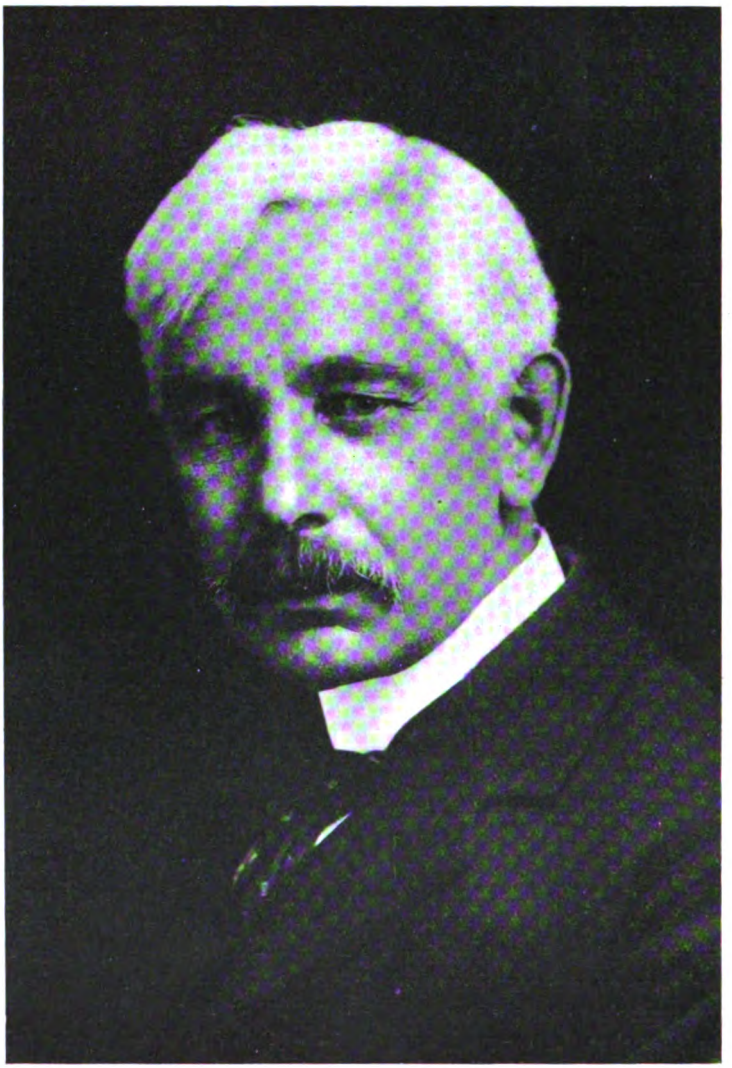

DR. CHARLES CHREE, F.R.S.

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Personalities in the Wireless World

DR. CHARLES CHREE was born in 1860 at Lintrathen, Forfarshire. He received most of his early education from his father the Rev. Charles Chree, D.D., a sound classical scholar, and after staying a year at the Grammar School, Old Aberdeen, entered Aberdeen University in 1875. In those days every would-be M.A. had to attend lectures and pass examinations in English, Latin, Greek, Mathematics, Physics, Logic, Moral Philosophy, and Natural History. After the usual four years' course Dr. Chree took his M.A. degree in 1879, being first in mathematical honours. He had taken prizes in all the subjects of the curriculum and received the Medal awarded to the most distinguished graduate of the year.

Proceeding to Cambridge, he entered King's College. He took his degree as sixth wrangler in 1883, obtaining a first class in the final parts of the Mathematical and Natural Sciences Triposes. Becoming a Fellow of King's College he resided in Cambridge until 1893, when he succeeded the late Mr. G. M. Whipple as Superintendent of Kew Observatory, a post he still holds. Until 1900 Kew Observatory was administered by a Committee of the Royal Society of which Mr. F. Galton was the last Chairman. As a Meteorological Station it was subsidised by the Meteorological Office, and it possessed an endowment, the Gassiot Fund, for the maintenance of the magnetic work. Its total secured annual income being less than £900, it was largely dependent for its existence upon its verification work which continued to increase rapidly with the result that a very satisfactory financial position had been reached before the Observatory became in 1900 a nucleus of the National Physical Laboratory. In 1910 the Observatory passed under the control of the Meteorological Office to which Dr. Chree is now attached.

Since 1884 much of Dr. Chree's time has been given to research. At Cambridge, working at the Cavendish Laboratory under Sir J. J. Thomson, he investigated the thermal conductivity of liquids and some magnetic properties of cobalt. His principal work then, however, was in connection with the mathematical theory of elasticity, and he continued this work after leaving Cambridge. The practical value of some of his mathematical researches has been recognised by the award of the Watt Medal by the Institution of Civil Engineers.

Dr. Chree's responsibility for the testing work at Kew led him to publish papers on Thermometry, Mercurial and Electrical, on Magnets, on Anemometers, on lag in mercury barometers and creep in aneroids, and on the effects of reduced barometric pressure on watches.

His principal research work since 1893, however, has been in terrestrial magnetism and atmospheric electricity, two branches of physics which are closely related to the problems of wireless telegraphy, and it is the connection of these subjects with aether-wave work which probably led to his inclusion in the British Association's Committee for Radiotelegraphic Investigation. For his researches in terrestrial magnetism he has recently been awarded the Hughes Medal by the Royal Society.

Dr. Chree is a D.Sc. of Cambridge, an honorary LL.D. of Aberdeen, an F.R.S., and an ex-President of the Physical Society of London.

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Notes on the Physics of the Thermionic Valve

By T. G. Petersen.

Summary of Theorems.

In order to make clearer the student's conception of the emission of electricity from hot metals in vacuo, it is proposed to summarize the kinetic theories in relation to (a) Gases, (b) Liquids, (c) Solids, and so lead up to the idea of evaporation.

The Kinetic Theory of Gases.

THE molecules of all gases are continually in a state of motion in straight lines, their courses altering only when they collide with others, or hit the boundaries of the vessel in which they are contained. It will be seen from this that the walls of the containing vessel are subjected to a molecular bombardment, or the gas may be said to be exerting a pressure against the sides of the vessel. With increase of temperature but constant volume the pressure exerted by bombardment is proportional to the absolute temperature of the gas. In other words, with increased temperature, the molecules attain greater velocities, and consequently the force and frequency with which each molecule is capable of bombarding the walls of the containing vessel are increased.

The Kinetic Theory of Liquids.

The molecules of liquids are in constant motion, at a lesser rate than are gas molecules, but differ from the latter in that they are unable to expand or fill an unlimited space, although they are able to take up the shape of the vessel in which they reside. In other words, there is a stronger tendency for the molecules to hold together in contradistinction to those of gases, which one may regard as having perfect elasticity, and hence, as being in contact with each other only during collision. In spite of this tendency of liquid molecules to hold together, they are evidently able to escape from the surface of the liquid, and in cases where the space around is not closely confined, may move away entirely, that is, evaporation takes place.

The Kinetic Theory in Relation to Solids.

In the case of solids the molecules are held together still more firmly, but it cannot be said that they are at rest, for even at temperatures below their melting points many solids are more or less volatile. That is, evaporation takes place, as instance the cases of solid naphtha and camphor.

Emission from Hot Metals in Vacuo.

Metals are "conductors" of electricity because there is in them an atmosphere of electrons (charges of negative electricity) in violent motion similar to the molecules of a gas. When a conductor comes under the influence of an electric field, the haphazard motion gives place to a definite direction of drift, according to the potential gradient of the field, thus constituting a flow of current. With increased heat the velocity (or energy) of these free electrons also becomes greater, and it is to be expected

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that some of them will become detached from the surface and move away from it. This is in fact what takes place; the mean square of the velocities of these electrons being proportional to the absolute temperature of the metal.

From the foregoing summary it will be seen that there is a similitude between the evaporation of solids and liquids, and the emission of negative electricity from metals. In short, electronic emission may be regarded as the evaporation of electricity.

Reasons for the Use of Tungsten as an Emitter.

In the following cases of the Thermionic Valve, it is proposed to deal with Tungsten as an emitter, and then only in relation to a pure electron discharge, such as occurs in dead-hard valves, but before passing on a comparison of Tungsten with other metals will, perhaps, not be unprofitable.

The only serious competitors with Tungsten as an emitter for Thermionic Valves are Platinum oxide-covered, Platinum-Iridium oxide-covered, and Carbon.

The prominent points for and against the previously mentioned metals may be summarized as follows:—

Platinum oxide-covered and Platinum-Iridium oxide-covered. Both of these compositions are good emitters, but fuse at low temperatures; also the degree of vacuum cannot be raised to the necessary value in their presence (see later remarks). The Oxides referred to are those of Calcium, Barium and Strontium.

Carbon. Although Carbon is an efficient emitter, its structure is such that when raised to temperatures essential to ensure sufficient emission, particles of the filament are thrown off vigorously, resulting in its rapid destruction.

It will be well, at this juncture, to point out that in valves employing a pure electron discharge it is necessary (1) to attain an exceedingly high degree of vacuum, and (2) to maintain such degree of vacuum.

(1) During the evacuation of the bulb it is essential to treat the anode to remove (as will be explained later) the gases occluded in the metal parts, and this process puts the filament to a severe test, under which all the substances mentioned, with the exception of Tungsten, would succumb before the gases had been liberated.

(2) If it were possible to remove all traces of gas from the metal parts before inclusion in the bulb, and assuming that merely by exhaustion the necessary degree of vacuum could be obtained, such vacuum could not be maintained in the presence of the oxide-coated metals named when they are heated to a temperature high enough to ensure anything like a sufficient emission. This is especially true in the case of oxide-covered Platinum filaments, and is due to the emission from the hot oxides of various vapours which of course lower the vacuum.

In Tungsten many of the faults of the substances discussed are absent. It has a high melting point (3270°C); its tendency to evolve Tungsten vapour is small even at the highest temperatures. Thus the loss due to material evaporation is little, even when it is maintained at high temperatures for long periods, whereas all impurities will quickly evaporate and be taken away during evacuation. The emission from it is steady for constant filament temperature, and it acts as a self-purifier, attacking all except the inert gases and forming compounds with them. The emission per centimetre length of filament is small, compared with that of other metals, but this de-

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ficiency is compensated for by its numerous good qualities.

It should be noted that pure Tungsten is rarely used in valve manufacture, the Tungsten of filaments usually containing a trace of Thorium. Pure Tungsten filaments have a decided tendency to sidestep or stagger, thereby becoming very fragile. The inclusion of Thorium rectifies this defect to a large extent.

Actual Cases of Emission from Tungsten.

Having briefly shown why Tungsten is found as the emitter in present-day valves, it is now proposed to show how values of emission currents may be determined.

The emission from a filament in a high vacuum may be calculated from Langmuir's $\frac{3}{2}$ power law, namely:—

$$i = 14.65 \times 10^{-6} \frac{l}{r} (V)^{\frac{3}{2}} \text{ ampères.}$$

where, i = plate current
l = length of filament (cms)
r = radius of cylindrical plate (cms)
V = applied voltage.

Now the current in a valve is limited on two accounts:

(1) The fact that there is a limit to the rate of supply of electrons dependent upon the temperature of the filament.

(2) The effect of the space charge, which partially annuls the electric force tending to drive the electrons across the space between filament and plate.

In the above equation the space charge effect is the only one of these two considered. That is, the filament temperature is raised until the valve current is limited by the space charge. Under this condition it should be noted that

(a) with increase of filament length (l) the emission current will increase.

(b) with decrease of the distance (r) between filament and plate, the emission will increase.

(c) with increase of voltage (V) the emission current will increase in proportion to $V^{\frac{3}{2}}$ up to a certain limit.

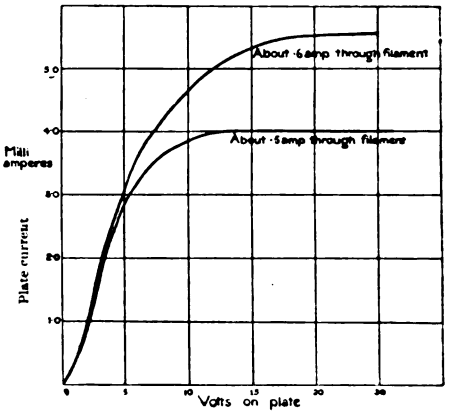

Fig. 1.

Fig. 1 shows the values of plate current obtainable in a small type receiving valve at the voltages indicated.

In Fig. 2 will be seen the values of plate current obtained in a medium power transmitting valve, with a constant voltage on the plate and with an increasing filament temperature.

It should be noted that in these two cases the plate and grid were connected.

It will perhaps be of interest to see how the transmitting valve case compares with the above equation. The constants of this valve are $l = 12$, $r = 0.875$, $V = 200$; substituting, we obtain $i = 14.65 \times \frac{12}{0.875} \times 2{,}830 = 567{,}000$ microamperes roughly, or 567 milliamperes, which approximates to the actual saturation value as shown in Fig. 2.

The Effect of Introducing a Grid.

Having discussed some of the underlying principles governing the production of thermionic currents in a two-electrode valve, it is now proposed to outline the effect of introducing a

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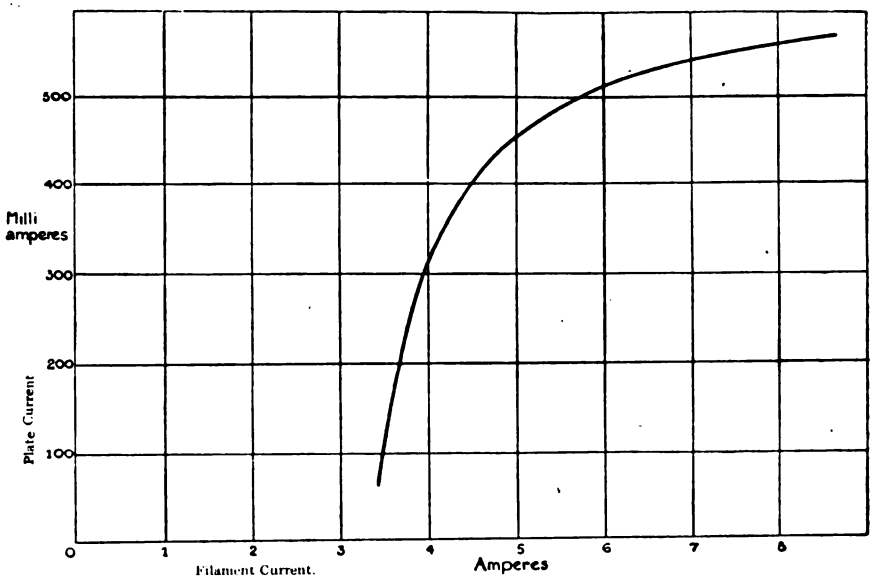

Fig. 2.

third electrode—the grid—interposed between the plate and filament.

In Fig. 3, the circuital arrangement which is to be considered, the grid is shown as a broken line G, P and F representing the anode (or plate) and the filament respectively. Also let E_B represent a battery maintaining P at a positive potential, and E_c a battery capable of being reversed and varied in its E.M.F.

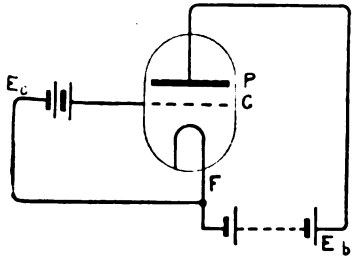

Fig. 3.

Now, for the moment, regard the grid as being connected directly to the negative end of the filament (*i.e.* with E_c absent) then its potential with respect to the filament will be zero. Although there is no difference of potential between G and F, there yet exists an electric field between them due to E_B, setting up a field at P, which, acting through the openings of the grid, has an attractive force upon electrons in the vicinity of F. This means that G must assume a potential difference with regard to F in virtue of its position between P and F. This will be readily seen by reference to Fig. 4, in which the disposition of the electrodes F, P, and G (which, it is assumed, has a mesh the openings of which are infinitely great) are shewn, and the gradient of the electric field set up by E_B between P and F, is represented by the sloping line P' F.

Now if the height E_B is proportional to the voltage of the plate battery, the

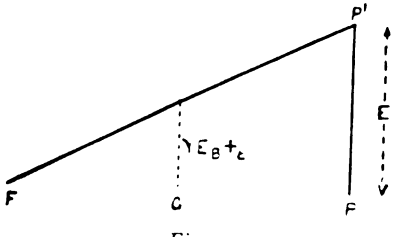

Fig. 4.

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effect of the stray field of E_B acting through the apertures of the grid, on an electron in the vicinity of F, is the same as if an E.M.F., equal to the height of the line G, were acting at G towards F. The value of this potential has been shewn to be equal to

$$\gamma E_B + \varepsilon *$$

where γ is a constant dependent on the mesh and position of G and varies between unity (when the mesh of the grid is infinitely great) and zero (when the mesh of G is very small) and ε is a constant dependent upon several factors but is negligible in comparison with γE_B. Therefore, calling the effect of the stray field at G, E_S, we have the expression

$$E_S = \gamma E_B$$

It should be pointed out that the consideration of the hypothetical case above is somewhat misleading on one point, namely, that since γ is unity, γE_B will be equal to E_B which could not be true.

G at zero potential and mesh of grid a finite size.

Take now the case where γ is somewhat less than unity—when the mesh is of finite dimensions—then the field due to E_B will be impeded in its action through the mesh of G, and the value of the stray field E_S will be decreased as illustrated in Fig. 5.

G at zero potential and mesh of grid very small.

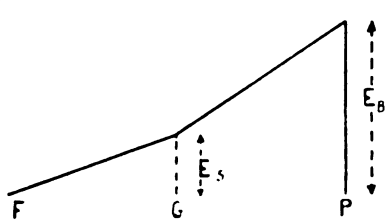

Fig. 5.

Further, if the mesh of the grid G be made very small, γ becoming zero, the strong field E_S will be nil, because E_B will be unable to operate through the openings of G. Since the electron-attracting effect towards the grid is entirely due to E_S it will be obvious that no current can flow through the tube. This case is illustrated in Fig. 6.

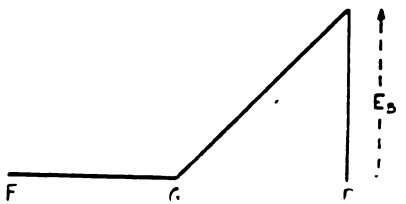

Fig. 6.

These illustrations will have made clearer, it is believed, some of the effects of the insertion of the grid, in so far as it affects the plate current, also that it is theoretically possible completely to cut off the flow of electrons through a three-electrode valve even when the grid is not at a negative potential with respect to the filament.

The effect on the plate-current-grid potential characteristic, of decreasing the mesh of the grid (or increasing the number of turns in the case of a spiral grid), is to move it bodily to the right into the region of positive grid potential.

Returning to the more practical case where the value of γ is somewhat less than unity, let us discuss the condition where the grid is maintained at (*a*) a positive and (*b*) a negative potential due to the battery E_C.

(*a*) *E_C positive, but less than E_B.*

Disregarding E_C for the moment, the field from E_B will be impeded by reason of the mesh of G, and the stray field may be represented by the whole of the line G in Fig. 7, but the grid has a field acting on F independent of E_B, which is due to E_C, and being positive

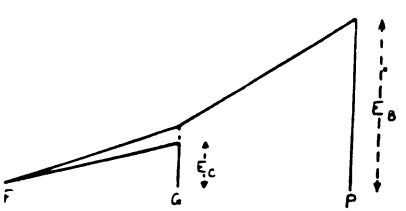

Fig. 7.

* Proc I.R.E., April, 1919.

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in sign assists the potential γE_B. The effect of these two positive E.M.F.'s is to set up a stronger field, which is equal to the line G, as depicted in Fig. 8. Thus with E_C positive the value of the stray field between G and F is represented by

$$E_S = \gamma E_B + E_C.$$

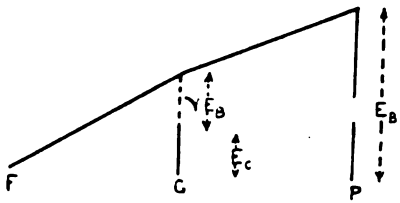

Fig. 8.

(b) E_C negative, but less than E_B.

When the grid battery E_C sustains G at a negative potential with respect to the filament, the case is different, since, as will be apparent, there will be an electric field set up which is in opposition to that due to E_B. Suppose E_C to be negative, but less than the value γE_B, then the field attracting electrons from the filament will be the same as if a potential equal to $\gamma E_B - E_C$ were given to the grid as is shown in Figs. 9 and 9a.

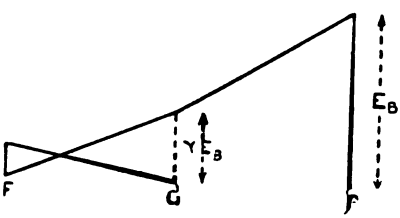

Fig. 9.

Obviously, since E_S is now diminished by reason of E_C, the force drawing the electrons to G (prior to their coming into the intense field of E_B between G and P) will be lessened, resulting in a corresponding decrease of current through the valve. Further, the flow of current will be completely stopped when the negative value of E_C equals the positive value of γE_B. This leads

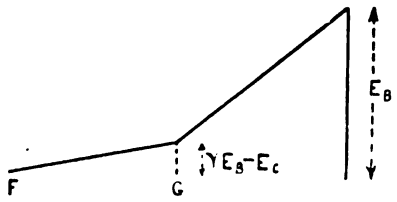

Fig. 9a.

to the statement that when E_C is negative the value of the stray field is

$$E_S = \gamma E_B - E_C.$$

To summarise the preceding remarks we may say—(1) With E_C constant an increase of turns on the grid (*i.e.* when gamma diminishes) results in decrease of current through the valve, and conversely a decrease of the number of turns on G (*i.e.* when gamma increases towards unity) enhances the valve current. (2) With γ constant, making E_C positive increases the plate current, and conversely, making E_C negative decreases the plate current until it is completely stopped, at which point E_C is equal and opposite in sign to γE_B.

Alteration of grid diameter.

While it is not suggested that the following is by any means a full explanation of all the effects of the alteration of the position of the grid relative to the filament and anode, it is believed, however, that it will serve in conveying to the reader's mind the elementary principles involved. It will be seen from remarks that follow, under the heading of operating constants, that as the grid nears the filament the voltage amplification factor will become less, and as a result the current through the valve will increase; but, although this is obvious from the equation referred to, it is proposed to show graphically the effect of change of grid diameter.

Retaining the electric field slope conception, in Fig 10 it has been assumed that γ has some finite value, which results in the stray field equivalent to the height JG. Now let the grid be moved to the positions G_1 and G_2 in turn. In the first case G_1, the screening effect of the grid will be less

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than when at G, in other words the stray field will have increased, and since this value E_S is proportional to the current through the valve, this will now also be greater. Conversely, when the grid occupies the position G_2, further from the filament, the screening effect will be greater and the resultant thermionic current smaller than when at the position G.

In the above we have assumed that the grid was at zero potential with respect to the filament. Suppose now a negative potential be given to the grid, and call this E_C as indicated in Fig. 10, then the resultant stray fields, relative to the three different positions of the grid, will be readily seen by reference to the diagram, where E_C has been deducted from them. At the position G_2 the flow of current will be seen to have fallen to zero.

On the other hand if the grid potential is positive but equal in value to E_C, it is easy to see that the dips in the slopes will be raised to the points P, Q, and R, respectively.

From the foregoing the general statement may be made that, as the grid is brought nearer to the filament, or as its diameter is decreased, the current through the valve will increase, such a result being due to the lessened screening effect of the grid upon the field of E_B. *(To be continued.)*

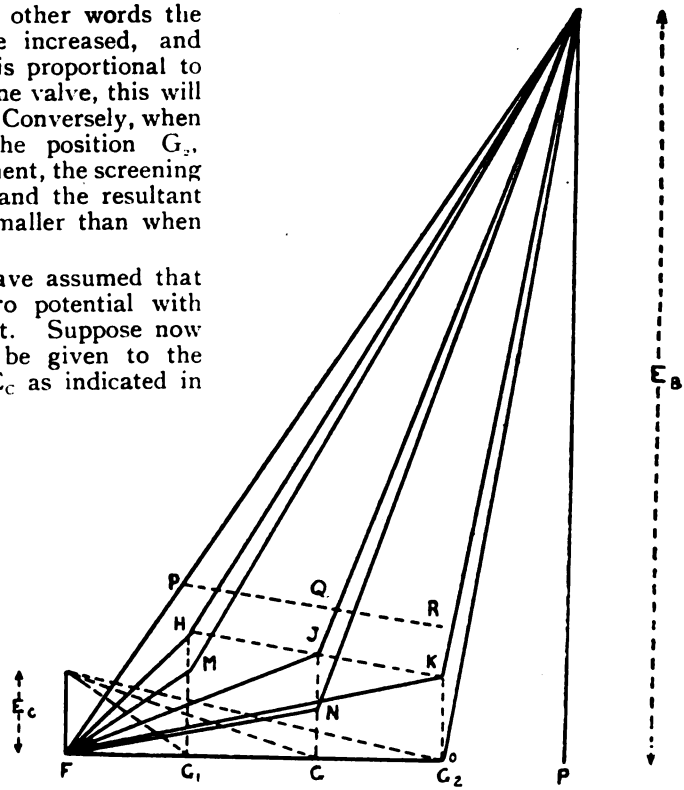

Fig. 10.

Some of the Contents of the February Number

The Training of an R.A.F. Wireless Operator (Illustrated).

How to make a Flexible Socket for Valves (Illustrated).

How to make an efficient Variable Condenser (Illustrated).

Full report of the proceedings of The Wireless Society of London. (Business, Paper by Dr. J. Erskine-Murray, Discussion and Reply.)

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Stray Waves

THE AMATEUR POSITION.

'TIS a poor heart that never rejoices. Since we last went to press no further developments of the situation have been made public, and the amateur wireless world has settled down to make the best possible use of available facilities. With the exception of the dimensions of the aerial matters are not so bad on the receiving side, and although many of us are inclined to say of our modest stretch of aerial, "A poor thing, but mine own," it must be remembered that much can still be done, especially with well-separated twin wires, whilst the frame aerial provides a fascinating and wide field for experiment.

It gives us pleasure to note the ever-increasing activities of the various wireless clubs and the rapid rate at which these young phœnices are rising from the ashes of 1914. So far we have twelve on record, and we shall be grateful to the Secretaries of any clubs with whom we are not in touch if they will make their existence known to us.

We direct the attention of all whom it may concern or interest to the following extract from the Radio Service Bulletin which issues from Washington:—

"Effective October 1, 1919, all restrictions on amateurs and amateur radio stations are removed. This applies to amateur stations, technical and experimental stations and colleges, and to all other stations, except those used for the purpose of transmitting or receiving commercial traffic of any character, including the business of the owners of the stations."

"The restrictions on stations handling commercial traffic will be removed as soon as the President proclaims that a state of peace exists."

"Before operating transmitting stations it is necessary to take an examination and secure an operator's licence and have on file with the district radio inspector a formal application for station licence. The radio inspector can assign radio call letters when the application is received."

"All amateurs should be familiar with the Radio Laws and Regulations. This publication can be procured from the Superintendent of Documents, Government Printing Office, Washington, D.C. Price, 15 cents."

"All transmitting sets should be inductively coupled. Stations having what is known as plain aerial, or the spark gap directly in the antenna circuit, will not be licensed where they do not comply with regulations 3 and 4 of the Act of August 13, 1912."

"The list of Radio Stations of the United States, edition of June 15, 1919, does not contain amateur stations. This publication can be procured from the Superintendent of Documents, Government Printing Office, Washington, D.C. Price, 10 cents."

* * *

WIRELESS TELEPHONY AND FOREST FIRES.

The United States Forest Service is now employing wireless telephone apparatus in connection with the reporting of forest fires. A case recently arose when such a fire was reported by wireless telephony from a portable instrument from a mountain top 11,125 ft. above sea level. These instruments

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have a range of several miles, and it is proposed that they shall derive their power from small wind-motors to make use of the powerful winds which are always present at such high altitudes.

* * *

THE WIRELESS STATION AT EILVESE (HANOVER).

A few details of the apparatus installed at this high-power station are given by A. S. M. Sorenson in the *Elektrotechnische Zeitschrift*. The antenna system is of the umbrella type, the central tower being 250 metres high with six 122-metre tubular masts surrounding it. The plant includes two Goldschmidt high-frequency machines which have given very good results. These machines can be operated in parallel if necessary, but it has been found that satisfactory communication with America can be effected using only one of them. L. V. Austin has measured the strength of signals received in America from Eilvese and from Nauen and obtained the following values respectively 21.6×10 amp. and 14.4×10.

* * *

THE MAINTENANCE OF MECHANICAL OSCILLATIONS BY MEANS OF THE THREE-ELECTRODE VALVE.

In a recent paper presented to the French Academy of Sciences, Messrs. H. Abraham and E. Bloch describe methods of using an ordinary three-electrode valve for sustaining the oscillations of a pendulum. The pendulum is fitted with a magnet influencing two coils, one connected to the grid circuit and the other to the anode circuit of the valve. By joining the windings in the proper direction the amplified currents from the valve may be caused to sustain the movement of the pendulum. If a multi-stage amplifier is used the effects can be increased and the pendulum will then start up from rest.

A similar arrangement may be used to sustain the tuning fork in vibration. It is particularly suitable for forks of high-frequency (1,000 or more per second) for which difficulties are sometimes experienced with the ordinary make and break contact.

Similar arrangements for tuning forks were also recently described by Dr. W. H. Eccles and F. W. Jordan.

* * *

THE DESIGN OF MULTI-STAGE AMPLIFIERS USING THREE-ELECTRODE THERMIONIC VALVES.

A paper on the above subject was read by Professor C. L. Fortescue at a Wireless Sectional Meeting of the Institution of Electrical Engineers on Wednesday, November 19th. The methods given in this paper were developed in the course of working out the design of valve amplifiers for naval wireless purposes. It deals with the simple case of a single valve used as a resistance amplifier, and by ascertaining that the working parts of the characteristic curves may be taken as straight lines the equations for the voltage amplification are developed. After considering various ways in which more than one valve may be connected in cascade to form a multi-valve amplifier the author dealt with the reaction effect due to reaction coupling between various valves.

The paper was largely devoted to the derivation of the mathematical expressions for the amplification factors of the various valve arrangements, and a general expression was also given for a number of valves in cascade.

The paper was followed by a discussion which was opened by Professor Howe and continued by Mr. L. B. Turner, Mr. Catterson-Smith, Captain H. J. Round, Major J. Erskine-Murray, Captain Slee, Mr. B. S. Gossling, Mr. J. Scott-Taggart, and Dr. W. H. Eccles.

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Digest of Wireless Literature

SIMULTANEOUS SENDING AND RECEIVING.

By E. F. W. ALEXANDERSON.

PROCEEDINGS OF THE INSTITUTE OF RADIO-ENGINEERS, AUGUST, 1919.

MOST workers in radio-telephony must have observed that the interchange of ideas is not satisfactory if it is necessary to manipulate a switch of some kind to change the set from the sending to the receiving arrangement. It thus can be said that one of the most important problems from the point of view of making radiotelephony useful to the general public is to devise a simple method of duplex operation whereby the speaker can hear the voice of the other party as is the case in line telephony. Fessenden was the first worker to devise such a scheme, the same aerial being used for simultaneous transmission and reception. The method, however, involves a very high degree of selectivity between the sending and receiving wavelengths and bristles with difficulties when carried out on a practical scale.

The present account deals with attempts to solve the same problem in different ways. The first method that yielded practical results was to use separate sending and receiving antennæ located sufficiently far apart so that only an ordinary degree of selectivity was required to enable one to differentiate between the wavelengths of the sending and receiving stations. Each pair of sending and receiving stations were connected by means of telephone wires, and also connected to the local telephone exchange so that any subscriber could use the radio-system. The diagram of connections is shown in Fig. 1. The subscriber and the sending station are connected together like the ordinary subscribers to a line telephone exchange. It will be seen from the scheme of connections that any signals received on the receiving antenna will be transformed into a current flowing in the closed circuit between the subscriber's instrument and the instrument in the sending station. Thus the message will be transmitted in the same way as the current carrying the voice of the local subscriber. Thus both sides of a conversation are transmitted by each sending station and a third party can hear both sides of the conversation by tuning in alternately on the two wavelengths.

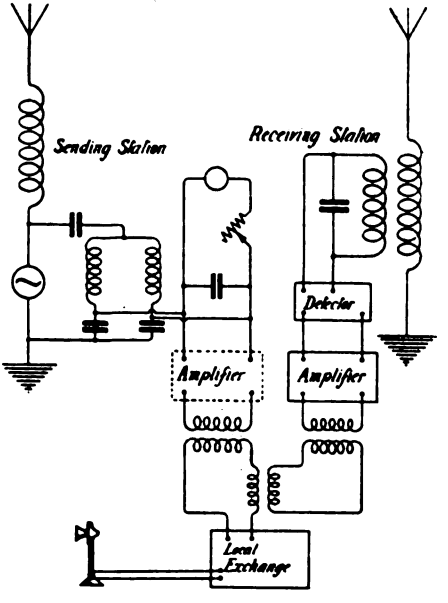

Fig. 1.

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The above method will probably prove the most practicable for communication over long distances between subscribers of telephone exchanges. There are, however, cases in which connection with a local exchange is not practicable. For example in the cases of emergency communication between sub-stations of electric power systems, or in the train radio-telegraphic service, it is essential that the sending and receiving equipment should be a unit controlled by the same operator. The most desirable arrangement under these conditions would, of course, be some circuit analogous to that of Fessenden. As a result of experiments on this subject the final solution was an arrangement with a neutralized receiving antenna mounted on the same mast as the sending antenna. This method will now be described in greater detail.

In the general case of two aerials mounted on the same mast the radiation from one to the other is so strong that the effect of the sending set on the receiver is almost of the same order of magnitude as the effect with the aerials joined together. Two methods of neutralizing the effect of the sending aerial on a receiving aerial fixed on the same masts have been developed. These may be termed the methods of inductive neutralization and capacity neutralization respectively.

The connections used in the method of inductive neutralization are shown in Fig. 2.

Here S, the sending antenna, is mounted on the same masts as R the receiving antenna, two separate leads-in being used. The oscillations in the sending antenna affect the receiving antenna in two ways, (a) by direct exposure from aerial to aerial, and (b) by direct and inductive connection by means of the neutralization transformer T. This transformer T is so designed that these two effects are approximately equal in

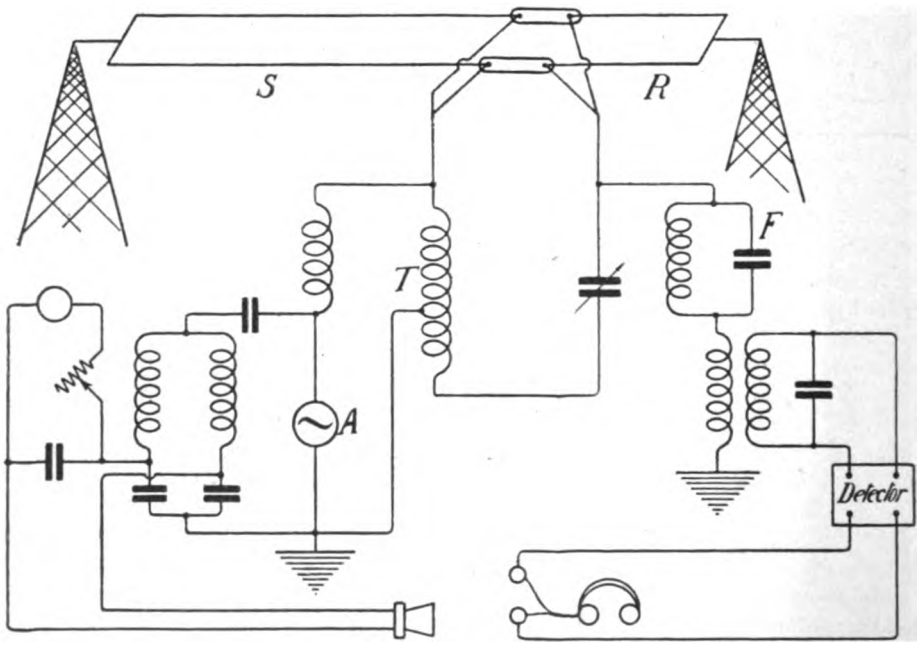

Fig. 2.

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magnitude and 180° out of phase, in which case they tend to neutralize each other. In most cases this adjustment can be made so that only a slight residual potential effect is left in the receiving antenna. This can usually be eliminated by the frequency trap F.

The system for capacity neutralization is shown in Fig. 3a.

The receiving antenna R is connected through a shielded primary loading coil T to a condenser C_3 and thus to earth. This loading coil is coupled aperiodically to the secondary of a receiving set (not shown in diagram) of any ordinary type. By means of the condensers C_1, C_2 and C_3 the effect of the sending antenna on the coil T can be reduced to zero. The theory of this arrangement can perhaps best be understood by consideration of Fig. 3b which represents the connections of Fig. 3a re-drawn in the form of an ordinary Wheatstone's bridge. Here the letters have the same significance as in Fig. 3a, and C_4 represents the capacity between the receiving antenna and earth. If the potential differences are so arranged that B and D are at the same potential (as in the case where a "balance" has been obtained in an ordinary Wheatstone's bridge) no effect will be produced in T and thus no effect in the receiver. This result can be brought about by suitable adjustment of the condenser C_2.

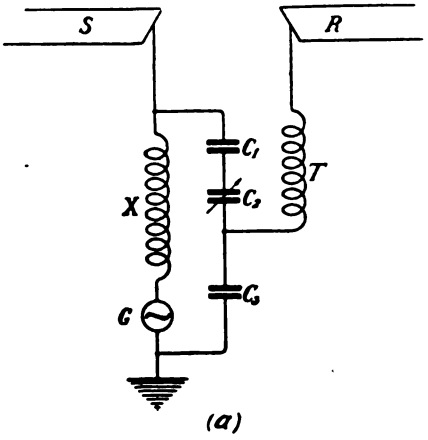

Fig. 3 (*a*).

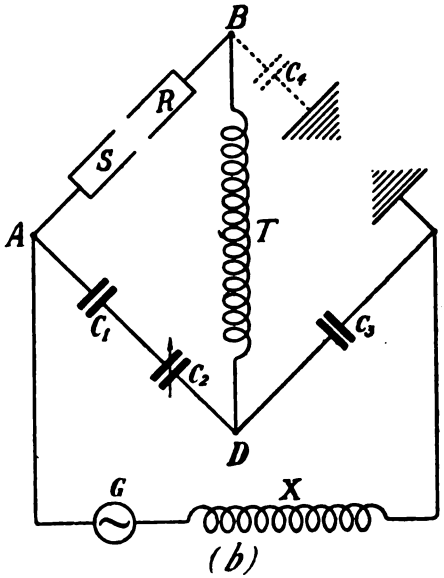

Fig. 3 (*b*).

As an example of the effectiveness of these methods the following details may be cited. In some tests made at Schenectady the receiving antenna consists of five wires mounted as an umbrella around the main mast while the sending antenna consists of two wires extending from this mast to another building. The mutual capacity of the two antennæ is such that 10,000 volts in the sending antenna produce 500 volts in the receiving antenna when it is disconnected. It is obvious that an oscillating voltage of this amount in the receiving antenna would preclude the use of the ordinary methods of reception. Yet the neutralization system has enabled the receiving antenna to be used for the reception of signals from the Pacific coast (2,500 miles distant) without any appreciable interference from the main sending antenna when the latter was radiating 20 ampères at 10,000 volts.

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How Aeroplanes are Navigated by Wireless

By R. KEEN, B.Eng.

Part II.

WHILST the principles governing the navigation of aeroplanes by wireless are fairly simple by comparison with astronomical navigation, the achievement of satisfactory and accurate results has presented many problems since the Wireless Direction Finder was first put to this use.

Probably the best method of gaining an insight into the practical side of wireless navigation will be to trace in outline the installation of a D.F. in a standard type of aeroplane, indicating some of the more important troubles which are experienced, how they are avoided and finally the rather striking results which may be confidently expected with modern apparatus.

Suppose the fuselage of a large passenger-carrying machine to take the form shown in Fig. 1. The D.F. apparatus is located right forward in the main cabin, so as to be out of the way of the passengers and the front seat is occupied by the operator who may also be the navigator. He will be in telephonic communication with the pilot, and both navigator and pilot have magnetic compasses. It will frequently be necessary for the navigator to take simultaneous readings of the magnetic and wireless compasses for reasons explained in Part I* of this article and the pilot needs a magnetic compass in order to make the course which is given him by the navigator. Having decided on the disposition of the apparatus, the next thing to be settled is the arrangement of the two frame aerials which, it will be remembered, have to be at right angles to one another. The obvious method is to run one of these aerials round the wings and the other round the fuselage; this is found to be quite satisfactory. Small frames are sometimes used in the interior of the machine in place of the large fixed aerials and separate D.F. instrument, but this article deals only with the latter arrangement. The receiving power of small frames is less, necessitating higher amplification of signals and also the larger frame is more directive.

The fixing of the wing aerial does not offer any great difficulty. Starting from a leading-in tube under the fuselage, rubber insulated wire is "doped" on to the fabric under the lower plane, and taken along to a point under the end strut. It is then taken through the lower plane, up the back of the strut and along under the top plane to the corresponding strut at the end of the other wing and so by a similar route, back to the leading-in tube. The fuselage aerial offers a little more trouble. In order to make this frame of the same area as the wing aerial it is necessary to erect short masts at either end of the fuselage, adjusting their height until the receiving power of the two frames is approximately the same. A foremast is also essential in order to allow the aerial to clear the pilot and front passengers. Fig. 1.

* WIRELESS WORLD, October, 1919, p. 389.

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shows how these masts may be fitted, care being taken that the after one does not project far enough through the fuselage to foul the tail skid or to be broken in a bumpy landing. Bare wire may be used for this aerial and must be strong enough to ensure that there is no danger of it breaking and fouling the propellers. It is carried up the masts, under the fuselage and over the top plane through porcelain insulators, supported in metal clips, and is led in with rubber covered wires along with the other aerial. The photograph on page 414 of the October issue of the WIRELESS WORLD shows an aeroplane fitted with D.F. apparatus, the masts and the insulators under the fuselage being well illustrated.

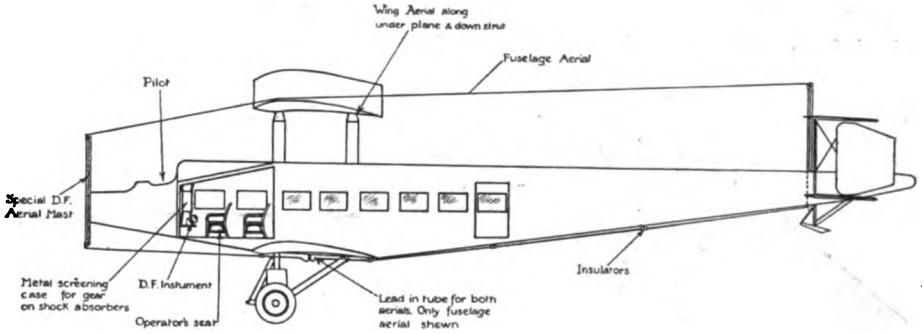
Wing Aerial along under plane & down strut
Fuselage Aerial
Pilot
Special D.F. Aerial Mast
Metal screening case for gear on shock absorbers
D.F. Instrument
Operator's seat
Lead in tube for both aerials. Only fuselage aerial shown
Insulators

Fig. 1.

The apparatus to be installed consists essentially of the direction-finding instrument, the valve amplifier with high and low voltage batteries, a screened transformer, and also apparatus for tuning the receiving circuits and aerials. A specially simplified system is in use on aircraft whereby only one adjustment is necessary when changing wave, the aerials and receiving circuits being simultaneously tuned to the required wave-length. Fig. 2 shows a photograph of one of the latest forms of D.F. instrument removed from its case, and by comparison with the diagramatic sketch of the instrument in Part 1, the two field coils (each wound in two sections) and the cylindrical tight coupled search coil can easily be traced. With the possible exception of the D.F. itself, the whole of this gear is enclosed in a metal screening case, supported from the roof, floor, and bulkhead by means of shock absorbers. Each piece of apparatus is in a separate compartment in the case in order to provide complete electrical screening. The pairs of aerial leads from the leading-in tube are respectively twisted together and all precautions taken to avoid mutual induction between the aerials. It will be noted at once that the aerial system is not symmetrical about the line of intersection of the planes of the two frames, but so long as the two frames are exactly at right angles this is not found to be of any great importance. If in spite of every care, a certain amount of mutual induction is found to exist between the aerials, this can be corrected by disposing the aerial leads from the leading-in tube to the apparatus, so that an equivalent amount of mutual induction exists in the reverse direction, the total effect being nil.

The set is now ready for the reception of signals. On tuning in to a long wave, with the aeroplane standing on an aerodrome near London, the signals

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from Clifden or Nauen should be painfully loud and audible at a considerable distance from the telephone receivers. This is always provided, of course, that the search coil of the D.F. is swung round to the position of maximum strength of signals from the station in question. At right angles to this direction, the search coil will receive no signals and the pointer of the D.F. can be adjusted so that at this silent position, it indicates the direction of the station, the bearing of which has been previously obtained either by calculation or from a Gnomonic Chart as explained in Part 1. Although the D.F. is now in operation, certain corrections must be made before accuracy can be obtained. Suppose that whilst signals are being obtained from a distant station, the direction of the station is noted and the whole aeroplane is then swung through a known angle. It will quite probably be found that on taking the direction of the station again the difference in reading on the D.F. is NOT the same as the angle through which the plane was turned. This is due to the metal parts of the engines, stays, etc., receiving and re-radiating the signals and thereby influencing the direction finder. By a fairly simple process of introducing choking coils and other devices, this and also any difference remaining in the receiving power of the two aerials may be allowed for and accurate reading obtained all round the scale. The operation coincides with the compass trials of a new ship in which case corrections have to be made for the effect upon the

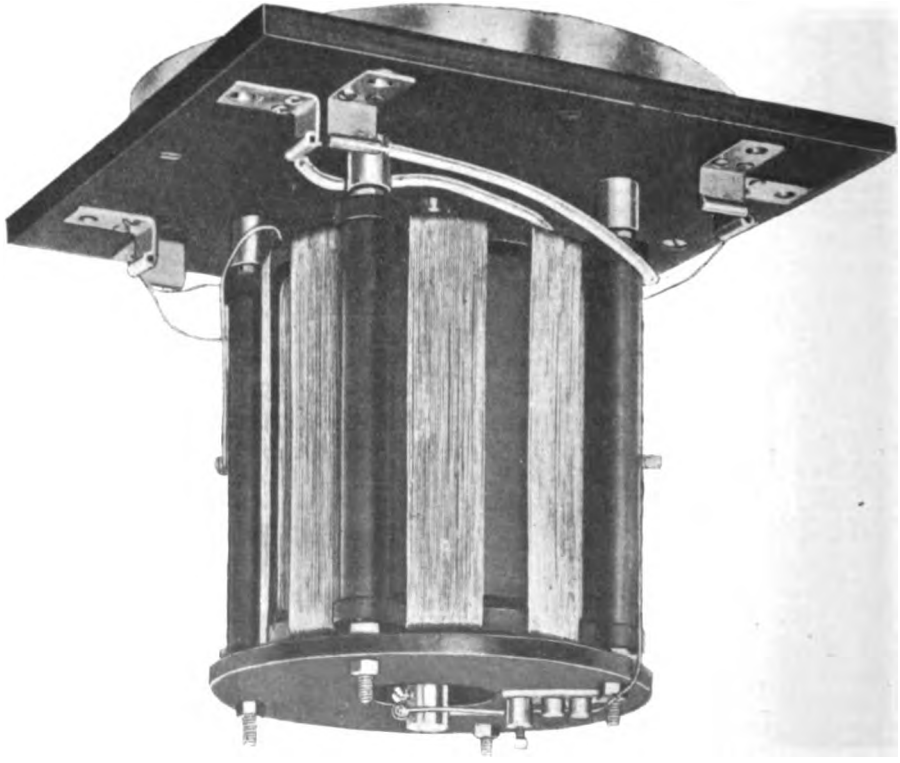

Fig. 2.

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magnetic compass of the permanent and temporary magnetism of the hull of the ship. It should be clearly understood that in the case of the D.F. installation here described, namely, with large fixed frame aerials, the operation of correcting the wireless compass forms an exact parallel to that of correcting a ship's compass in that the corrections, once being made, are permanent; the instrument giving accurate readings direct from the scale. In the case of a D.F. using the small rotating frame, the position of which relative to the machine, is constantly changing, a chart of corrections is supplied and it is necessary to consult this and obtain a correction factor each time a reading is taken.

All is now ready for a trial engine run and the serious difficulties at once make themselves apparent. Immediately on starting the engines, a deafening roar is heard in the telephones completely drowning the strongest signals, and this continues without intermission until the engines are shut down. This noise is the induction from the ignition circuits and magnetos of the engines. On large aeroplanes having four engines, each with twelve cylinders, and making some 1,500 revolutions per minute, there will be 48 spark plugs producing 36,000 sparks per minute. To each of these plugs is attached a considerable length of high tension lead which oscillates as a plain aerial each time a spark takes place. Taking into account the fact that a machine similar to that shown in the sketch and fitted with standard D.F. and receiving gear is able, when standing on the ground in England, to receive readable signals from American stations, the reader will readily appreciate the difficulties which arise on attempting to cut out the jamming from what practically amounts to 48 plain aerials all sparking INSIDE THE FRAME AERIALS.

The first and most obvious precaution is to put a metallic screen round all magneto leads and controls and connect these screens to the metal framework of the aeroplane and engines. The lighting leads and also the leads to auxiliary electrical machinery have currents induced in them by the magnetos and also have to be screened, and all the metal parts of the fuselage and wings must be bonded together and "earthed" on to the engines. A large amount of ingenuity has been shown in the various methods which have been evolved for eliminating magneto noise by screening and also by specially designed wireless apparatus and ignition systems, and by an intelligent use of them the problem has been solved. The external noise from the engine exhausts is another troublesome factor, but if the telephone ear pieces are sewn into the operator's helmet and kept well pressed to the ears, this noise can, to a large extent, be cut out.

The valve amplifier has played a large part in making D.F. work on aeroplanes a practical possibility, and the person who finds himself in an aeroplane to-day —more particularly if he be a pre-war wireless enthusiast—will find it difficult to believe that with the aerials available, it is comparatively easy to take directions of transmitting stations at distances of several hundred miles in the midst of a noise which renders conversation very difficult and frequently impossible.

The installation of a small two-seater machine offers new difficulties. In this case the pilot himself should be able to operate the D.F. and what is more, it must not add more than is absolutely necessary to the array of apparatus which he already has before him. This is accomplished by the use of a miniature form of D.F. instrument and circuit tuning device, all the more bulky apparatus being located in the fuselage of the machine with remote controls for the amplifier. If the machine is fitted with

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a wireless telephone set, it is not necessary, in general, to instal a second one for the D.F. as any standard valve amplifier is suitable for the work in connection with both sets.

When flying in a strange district where the bearings obtained by D.F. have to be plotted out carefully on a chart, it would be necessary to have an observer to do this work, but once the route is well known, the pilot will have little difficulty in recognising the notes of the various stations in range—especially if beacon stations are erected for the purpose—and from constant practice will be able to know to within a remarkable degree of accuracy when he has reached his destination.

NOTES ON THE MEASUREMENT OF WAVELENGTH AND H. F. INDUCTANCE AND CAPACITY.

By B. WILLIAMS, B.Sc.

IN measurements of wavelength of oscillatory circuits either damped or undamped waves may be employed. In the former method the circuit to be measured is excited by means of a buzzer and the wavemeter is adjusted for maximum sound in the telephones. No matter how loose the coupling between the two circuits there is always a doubt as to the exact setting of the wavemeter condenser for resonance. When using continuous waves the circuit to be measured must be made to generate feeble continuous oscillations which, interfering with the oscillations generated by the C.W. wavemeter, produce beats in the telephones of audible frequency. The frequency of this note in the telephones can be varied by altering the wavemeter frequency and is zero when both circuits are in resonance. There is always a slight range on the condenser during which nothing is heard, and therefore the correct setting of the condenser is again in doubt.

It is a well-known fact that if an oscillatory circuit is coupled to a circuit which is *just* generating undamped oscillations, or the coupling between grid and sheath coils is just tighter than required for the oscillating point, the latter will cease to oscillate when the two circuits are in resonance. This is accompanied by an increase in sheath current if there is a grid leak in the generating circuit, or a decrease in sheath current if there is no grid leak in circuit. This is shown by a milli-ameter in circuit or by a click in the telephones. Usually in practice there are two points on the wavemeter condenser at which this appears, corresponding to the two apparent wavelengths of the oscillatory circuit due to the mutual induction between the two circuits. These points on the condenser are the nearer together the looser the coupling between the circuits, and therefore by sufficiently loosening the coupling the two clicks will coincide. Alternatively the real setting of the wavemeter condenser can be found by taking the mean of the readings of the condenser when the clicks are heard. As the clicks are perfectly sharp and definite there can be no personal error in reading the condenser.

This method does not require the circuit under measurement to be fitted up to generate either damped or undamped waves and it is certainly more accurate than either of the usual methods.

The setting of the wavemeter to *just* generate continuous oscillations may be effected by the variation of reaction coupling or by a finely variable rheostat in the filament circuit. For the measurement of H.F. values of inductance and capacity it is only necessary to make either the capacity or inductance part of the oscillatory circuit under test a standard.

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An Experimental Station

By E. Ludwig.

(We publish the following article as it describes a neat and ingenious amateur experimental station, and may be suggestive to other private workers. Most amateurs, no doubt, will wish to use valves for reception and the necessary adaptation of the circuits here shown should not present much difficulty. British amateurs must use an aerial slightly smaller than the one described.)

MANY amateurs do not carefully enough protect their stations from lightning. Even the smallest discharge may ruin at least the detector. The connections shown in Fig. 1 give a very efficient protection of the whole receiving station and of the detector itself.

See Fig. 2.—*The aerial Æ* (Inverted L type) consists of 6 ten-metre lengths of No. 14 S.W.G. hard drawn copper wire kept 50 cm. apart by wooden hoops 1m. in diameter, suspended from a mast on the roof of a building to another 10 m. high. From the hoop on the roof 6 downleads are stranded into a cable for about 1 metre before entering the operating room to be connected to the lightning protector. The "earth" is connected in the usual way.

The lightning protector LP consists of two choke coils of about 30 turns of No. 6 (Birmingham W.G.) on a porcelain core of 3″ diameter with lever switches as illustrated. When using the station, open 2, close 1 and 3; if not using station, close 2 and open 1 and 3. Choke coils are more advantageous than insulators would be (Fig. 1).

The change-over switch (4) leads to the instruments. On the two-way switch (5) telephone fuses are mounted. This switch brings into circuit two jiggers: $L_1P_1S_1$ and P_2S_2; L_1 is an inductance (loading coil) made of a cardboard tube 4″ long, $3\frac{1}{4}$″ diameter, on which 100 turns of No. 20 S.C.C. S.W.G. are wound and tappings taken to a multiple-way switch on the box in which the inductance is mounted. P_1S_1 is a loose coupler as described by Mr. J. F. L. Corkett, i.e., a wooden square former for both primary and secondary windings.

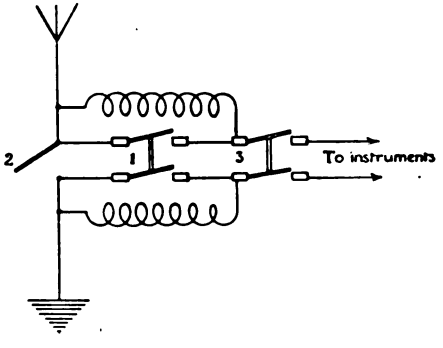

Fig. 1.

P_2 S_2 is a stationary coupler which does the rough tuning. The secondary S_2 consists of No. 28 S.C.C. S.W.G. copper wire on a cardboard tube 4″ diameter, 8″ long, tappings being taken through holes in the tube to the multiple-way switch on box. Over the secondary a piece of insulating cloth is fixed by means of shellac varnish and over this the primary is wound (No. 22 D.C.C. S.W.G.). Tappings are taken to switches

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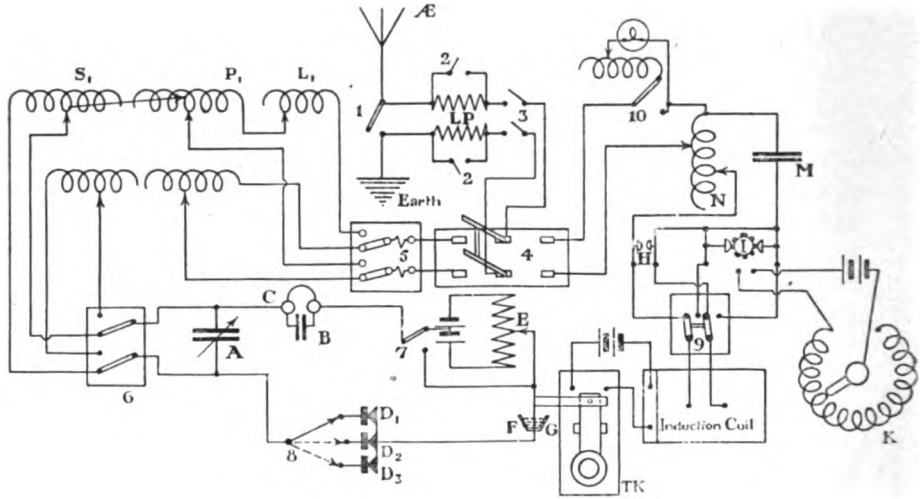

Fig. 2.

on the same box in which this coupler is mounted.

Both secondary coils S_1 and S_2 are connected to switch (6) mounted on condenser below.

The telephones (c) have a resistance of 3,500 ohms. The blocking condenser B has 3 capacities: ·001, ·002, ·003 microfarad. The switch (7) puts into circuit a potentiometer E for use with carborundum detector D_1. A crystal cup holds a carefully-selected piece of the crystal by means of an alloy, the melting point of which (140°F.) does not affect the crystal. The alloy is made by fusing together 4 parts of Bismuth, 1 of Cadmium, 2 of Lead, 1 of Tin. The crystal presses against a steel surface. Switch (8) allows the use of one of the 3 detectors. D_2 is a zincite-tellurium type (no potentiometer); D_3 is Molybdenite, very robust and reliable, but only for short range work or strong signals. F is a mercury cup (Figs. 2 and 3) which opens the detector circuit every time the transmitting key is pressed down, regardless of the position of switch (4). It saves the detectors from fusing or burning out. A piece of ebonite is screwed to the end of the key at right angles to it. It carries a connection from detector circuit with an electrode in contact with the mercury; this electrode should be adjustable, of course. This completes the receiving circuit.

Switches 5 and 6 can be converted into a single rotary as shown in Fig. 4. This is an ebonite disc with brass segments A (shaded) and thin brass ribbons to terminals B. 1, 2, 3, 4, 5, 6, 7, 8, are brass spring contacts which end at terminals B. A lever H brings in circuit L_1, P_1, S_1, at position 1, and P_2 S_2 at 2.

THE VARIABLE CONDENSER A.

This can be made very easily by coating two photographic films (from which the sensitive gelatine has been removed by means of hot water) with tinfoil to $\frac{1}{2}''$ from the edges. These coated films are wound on their original spools and fixed to them by one end. Two ebonite discs, 2″ in diam., are centred and a brass bolt passed through each of their centres and held in position by a small nut on either side. Ebonite rods are fixed in the recesses cut in the

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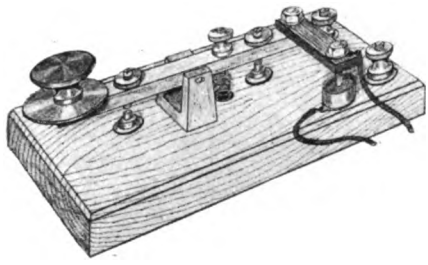

Fig. 3.

discs and form a cylinder which will not be affected very much by expansion from temperature. To one of these rods the loose end of one film is fixed and electrically connected to one of the brass bolts. The other film is connected to the other bolt and fixed to the next ebonite rod. The spring bearings rubbing against the nuts will ensure a good contact, and if these springs are mounted on ebonite and connected to terminals the condenser will be complete in its principle by rotating the ebonite cylinder by the handle at one end. (See Fig. 5.)

Four pieces of brass will be the bearings of four brass screws driven through them into the store-spools. A spring on each spool should store the films as soon as the handle is turned back. The pressure of the spring bearings should be sufficient to overcome the action of the springs.

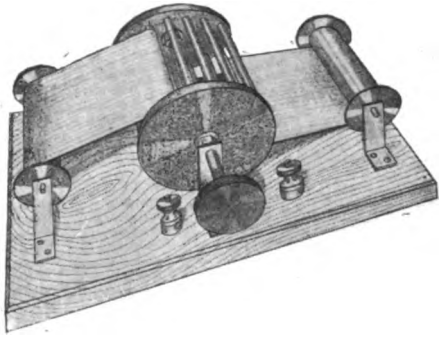

Fig. 5.

If the experimenter wants to calibrate his instrument, he can do it by the Bridge or Wavemeter method. A circular scale can be put round the handle and for observing the number of rotations a cam can be soldered to the axis for moving a toothed ebonite disc, one tooth

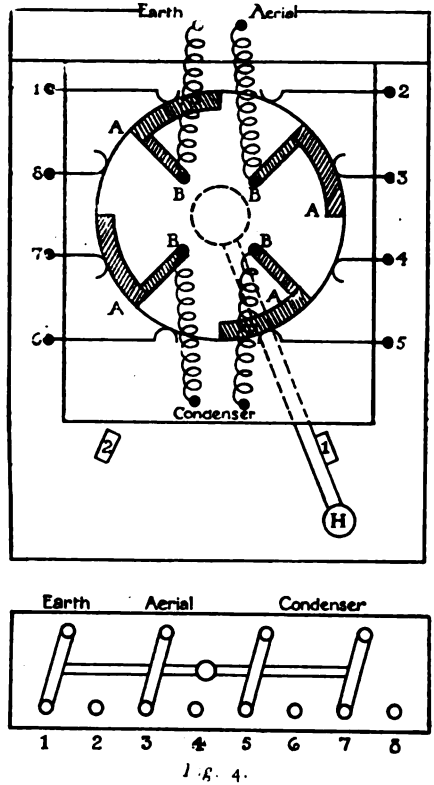

Fig. 4.

for every revolution. A pointer fixed to the axis passing through the edge of the box will indicate the number of turns. It is understood that the films are fixed to the cylinders by their celluloid side. The whole is mounted on a box and if the rotary switch is not used, switch 6 should be mounted on top of the condenser and the terminals on the base.

The transmitting station is quite simple; its range is about 5 km. The induction coil gives a 1·5 cm. spark and is

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connected by a 2-way switch to a fixed or rotary spark gap. The condenser consists of 35 sheets of tinfoil $3\frac{1}{2}'' \times 2\frac{1}{2}''$ interleaved with photographic quarter-plates $3\frac{1}{4}'' \times 4\frac{1}{4}''$. The whole is kept together by insulating tape and is bathed in paraffin wax. It is then put in an ordinary wooden box fitted with terminals. This is then fixed into a box containing the battery (storage) for motor of spark gap, its rheostat on one side, switch 9 in front of spark gaps on top, and terminals on base.

The Helix (I used it as a standard) has its heads 7" apart and the wire used is No. 6 Birm. G., seven complete turns $\frac{3}{4}''$ apart. Diameter of each turn is 10". The total inductance is about 14 mhys. Finally let us consider the tuning lamp (ordinary flashlight lamp 3·5 volts). The inductance consists of 8 ft. of bare 16 S.W.G. copper wire on a grooved

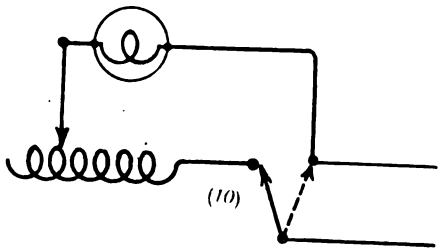

Fig. 6.

wooden former soaked in wax. One end of the wire is free, the other connected to terminal on baseboard. Another terminal is connected to one of the lamp contacts, the other being connected to a pivoted brass arm the extreme end of which may be moved over the inductance. The switch 10 cuts it out (Figs. 2 and 6).

A condenser for shortening the wavelength can be put in series between the tuning lamp and switch (4). (Fig. 2).

ROYAL NAVAL SCHOOL OF SIGNALLING
FOR
OFFICERS OF MERCANTILE MARINE.
HOURS OF INSTRUCTION
4-30 TO 7 P.M. EXCEPT SATURDAYS & SUNDAYS.

A group of Instructors and Pupils at the New School for Wireless and Signalling at Bombay.

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Notes of the Month

NEW COMPANIES.

A COMPANY under the title of the Marconi Scientific Instrument Co., Ltd., was registered on November 1st, 1919, with a capital of £12,000. The main objects of the Company are the manufacture and sale of amateur telegraphic and telephonic apparatus, the manufacture of apparatus under licence to be granted by the Marconi's Wireless Telegraph Co., Ltd., and the repair and bringing up-to-date of all obsolete apparatus. The first Directors are Messrs. Henry W. Allen, W. W. Bradfield, C. Mitchell, W. W. Drury (Managing), Charles B. Ward (and Secretary). The registered office and works are situated at 21-25, St. Anne's Court, Dean Street, W.C.

* * *

The formation of the Marconi Osram Valve Co., Ltd., was reported in these columns in our last issue. We since learn that the first Directors are Messrs. Henry W. Allen and Christopher Wilson. The Secretary is Mr. H. W. Corby and the registered office and works are situated at Osram Works, Brook Green, Hammersmith, W.

* * *

Further particulars of the Chinese National Wireless Company are now available. The Board of Directors is as follows: Vice-Admiral Chen Ngen-Tao, Chief of the Executive Board, Ministry of the Navy, Peking; Lt.-Col. Ting Ching, who was until recently Director-General of Military Operations, Ministry of War, Peking; Lin Chih-Hsin, a Chief du Bureau of the Ministry of Communications, Peking; Mr. Godfrey C. Isaacs, Managing Director of Marconi's Wireless Telegraph Co., Ltd., London; Mr. T. A. Barson, Chairman of the Peking Syndicate, and Mr. A. H. Ginman a Marconi representative in China. The Company is to utilise materials produced in China in preference to imported materials in all cases in which such materials are neither lower in quality nor higher in price than the imported materials. Chinese will be employed on the personnel as far as possible, and when the Company's Works are in operation the technical education of students will be undertaken by the Company.

* * *

A new Dutch wireless company, called the Nederlandsche Telegraaf Maatchappij "Radio-Holland" has been formed with a capital of one million florins. Under an agreement with the S.A.I.T. sans fil, which dates from April 1st, 1919, the "Radio-Holland" acquires the rights of wireless installations on Dutch mercantile vessels (Netherlands and Dutch colonies) and the contracts relating thereto.

* * *

WIRELESS TIME SIGNALS FOR SHIPS.

The Admiralty Notice to Mariners (No. 1993 of 1919), cancelling No. 1264 of 1919) gives a complete list of all time signals transmitted by wireless stations throughout the world.

It foreshadows a universal standardisation of signals and a regularisation of the times at which the Stations send out both these and the Wireless weather bulletins.

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DR. J. A. FLEMING'S LECTURES ON VALVES.

On November, 19th, at University College, Prof. Fleming continued his lectures on the Three-Electrode Valve, dealing, in his usual able manner, with the valve as an H.F. generator.

During his lecture he used for demonstration purposes the original valves used at Ballybunion Station for transatlantic experimental work.

His fifth lecture, on November 26th, dealt with the valve and its use in wireless telegraphy for C.W. and Spark transmission. He showed several standard circuits for audio or radio-frequency amplification and also a circuit for the combination of the two. Lord Rayleigh's "whistle experiment" to determine the smallest amount of power required to produce audible signals, was described in detail as a basis to prove how remarkably inefficient the present day magnet telephones are; on an average only $\frac{1}{700}$th of the power supplied to the receiving aerial reappears in the form of sound.

On Wednesday, December 3rd, Professor Fleming concluded his series of lectures by first of all giving a brief summary of the valve, from its discovery to its present day adaptations. He gave a detailed description of how to arrive at the internal resistance and the characteristic curve of a valve—also a brief description of how the P.O. is using the three-electrode as a relay adding considerably to the distance over which speech is being transmitted. To conclude he stated that he had a valve depending on different principles to those of the three-electrode, by means of which he hoped to be able to ring a bell across the Atlantic. The theory of it is complete and the only trouble to overcome is that of manufacture.

THE IMPERIAL WIRELESS CHAIN.

The Cabinet has approved the appointment by the Secretary of the State for the Colonies, as Chairman of the Imperial Communications Committee, of the following Committee to prepare a complete scheme of Imperial Wireless Communications.

In so doing it will deal with the following items:—

1. To consider what high power stations it is desirable on commercial or strategic grounds that the Empire should ultimately possess.
2. To prepare estimates of the capital and annual costs of each station, the life of the plant and buildings as taken for the calculation of depreciation to include an adequate allowance for obsolescence.
3. To examine the probable amount of traffic and revenue which may be expected from each station.
4. To place the stations recommended in their order of urgency.

The members of the Committee are:—

The Rt. Hon. Sir Henry Norman, Bt., M.P. (Chairman),
F. J. Brown, Esq., M.A., B.Sc.,
Rear-Admiral F. L. Field, C.B., C.M.G.,
Sir John Snell, M.I.C.E.,
J. E. Petavel, Esq., B.Sc., F.R.S.,
Dr. W. H. Eccles, M.I.E.E.,
J. Swinburne, Esq., F.R.S., M.I.C.E.,
L. P. Turner, Esq., M.A.,
Brig.-Gen. S. H. Wilson, C.B., C.M.G. (Sec.),
Lt.-Col. C. G. Crawley, R.M., A.M.I.E.E. (Assistant Sec.).

All communications in connection with the Committee should be addressed to the Secretary, 2, Whitehall Gardens, S.W.

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WIRELESS SERVICE TO SWEDEN.

The Postmaster-General has made arrangements with the Swedish Government for the establishment of a wireless service supplementary to the cable service between Sweden and this country. The rates are the same as by cable, 2½d. per word for ordinary telegrams and 1¼d. per word for Press telegrams.

* * *

LEEDS UNIVERSITY HONOURS ADMIRAL JACKSON.

The honorary degree of Doctor of Science was recently conferred by Leeds University upon Admiral Sir Henry B. Jackson, G.C.B., K.C.V.O., F.R.S.

* * * *

LECTURE BY DR. W. H. ECCLES.

At 6 p.m. on Dec. 3rd, at the City and Guilds Technical College, Finsbury, Dr. W. H. Eccles delivered to a packed audience a popular lecture on wireless telegraphy, condensing into the space of one hour a swift, historical sketch of the development of the art, concluding with a simple account of the working of triodes. Mr. A. A. Campbell Swinton occupied the Chair, and in proposing a vote of thanks to the lecturer, interpolated some amusing stories of his own "wireless" experiences.

WIRELESS CLUB NOTES.

The Wireless Society of London.

Will all those interested kindly note that the address of the Secretary (Mr. H. Leslie McMichael) is now 32, Quex Road, West Hampstead, N.W. All applications for membership should be sent to this address.

Entrance fee, 10s. 6d. Subscription, One guinea; Country members, 10s 6d.

Burton Wireless Club.

At a meeting of this Club on November 19th, Mr. A. J. Selby gave a lecture on Wireless Telegraphy to a large audience. Mr. A. Chapman (Editor of the *Burton Daily Mail*) presided. The Chairman announced that the specifications for the wireless installation it was proposed to erect had been submitted to the Government for approval. The Secretary stated that he had received a letter from the Wireless World stating that they would be delighted to help the Club collectively and individually, that the magazine was going to devote its pages more to the needs of the amateur and would welcome contributions from the Club. Mr. E. Blake, the Joint Editor of the magazine, was elected a Corresponding Member.

The election of officers being left over from the last meeting, Col. J. Gretton, M.P., C.B.E., was appointed President and Mr. A. Chapman, Vice President. A yearly subscription of 5/- was agreed upon as a membership fee.

In his lecture Mr. Selby traced the history of wireless telegraphy from its earliest stages, concluding with an account of the latest valve detector. He exhibited a model of a wireless set all contained in a wooden box about 8 inches in length, 1½ inches in depth and 4 inches wide. He explained that it was only necessary for the user to make contact with the ground by means of a stick with a steel ferrule and that no aerial was necessary.

Meetings of the Club are held every alternate Wednesday.

Another meeting was held on Wednesday, the 3rd inst., when there was a good attendance, and Mr. R. Chapman lectured on Magnetism and Electricity. The club has a Membership at present of about 25 or 30.

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Wireless and Experimental Association.

This go-ahead Club has lost no time in settling down to practical work. At a recent meeting the members were treated to a two hours' discourse by Mr. Greenslade, of the British School of Telegraphy, who gave an exceedingly interesting address of instruction and advice. The Association is now permitted by the P.M.G. to practice reception of signals and the members are energetically erecting the station, each one contributing some material or part.

There has been a subtle air of mingled earnest preoccupation and alert assimilation of new ideas among the members during the past month, betraying the fact that every member was making something for his own station.

Not that the Club station was neglected, for with contributions in kind the aerial has been put up, receiving apparatus furnished and good signals obtained.

The necessary manual assistance was willingly given, being ably directed by Mr. Saunders, the Assistant Manager.

The workshop is rapidly becoming complete in its appointments and many members are more than glad of the assistance which combined effort is able to make available.

The recent gales may have been disastrous to many buildings but so far we have not had bad news of any of our well-constructed aerials being wrecked.

We cannot put F.R.S. after our names but in spite of that we are nearly all Fellows Receiving Signals.

* * *

The Sheffield and District Wireless Society.

On November 14th Mr. F. E. Meredith delivered a lecture on the subject of Capacity and Inductance, the meeting being held in the Municipal Officers Club. Mr. H. E. Yerbury (President of the Society) presided over a full attendance of members. Applications for membership should be addressed to the Hon. Sec., Mr. L. H. Crowther, 166, Meadowhead, Sheffield.

* * *

The Radio Scientific Society.

All persons interested in wireless will be glad to know that those who remain of the local enthusiasts, who before the war composed the Radio Scientific Society, held a re-union in Manchester on December 3rd, when additional members were enrolled and an active programme was projected.

Though the war has laid a somewhat heavy toll on this Society, great zest for the work remains, as was evidenced by the profitable discussions which ensued after the ordinary business of the meeting.

The Radio Scientific Society will meet every alternate Wednesday evening at 7.30. Intending members and visitors can receive all additional information by applying to Mr. Peter Thomason, Woodside Engineering Co., Ltd., 7, Brazennose Street, Manchester; phone: Central 5735.

* * *

North Middlesex Wireless Club.

On Wednesday, Nov. 19th, with the President, Mr. A. G. Arthur, in the chair, the above Club held a most successful meeting which was well attended.

After the usual business and the enrolling of new members, the evening was devoted to the question of installing the Club's apparatus and the erection of

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aerial, etc. Keen competition was displayed among the very enthusiastic members of this Club for the honour of presenting the various instruments, etc., so that before the close of the evening the Chairman was able to announce that the Club had been presented with the aerial mast, the aerial and various instruments, proving that the North Middlesex Wireless Club is a real live Club and that its members are anxious to get to work.

Another meeting of the Club was held on Wednesday, December 3rd, the President being in the Chair. The chief subject under discussion was the most suitable way to erect an aerial pole outside the Club premises and a number of suggestions were put forward by various members. It is hoped that before the next meeting some definite plan will have been decided upon by the Committee.

The Club Library is now well established, and under the able supervision of the President, Mr. A. G. Arthur, will no doubt be of great assistance to members.

Will members kindly note that meetings have been arranged for alternate Wednesdays, commencing from December 3rd, and the practice of sending cards advising the date of the next meeting has been discontinued.

Full particulars of the Club can be obtained from the Hon. Secretary, Mr. E. M. Savage, "Nithsdale," Eversley Park Road, Winchmore Hill, N.21.

* * *

The Derby Wireless Club.

Service members having now mostly returned, the Club is resuming a more active interest in wireless telegraphy. Meetings have been held fortnightly since September, and many matters of interest discussed. All the local members' war experiences seem to have been with valve circuits, in the Army, Navy, and R.F.C. A member of the latter lately described some achievements in wireless telephony between aeroplanes and their base, over 200 miles away. One of the members of the Committee has had wide experience of D.F. sets and in fitting amplifiers in seaplanes, while another has been responsible for testing and selecting all the high power transmitting valves supplied for the Navy. Several papers on amplifiers, valves, circuits, and curves have been read, and a plasticine model shown representing grid current contours taken from a large American valve. Inductances and capacities can now be measured for members, and a calibrated C.W. wavemeter is available. Valve characteristics can also be taken. The 9th annual meeting is to be held early in January.

* * *

Glasgow and District Radio Club.

At a meeting of old members held on Thursday, November 20th, it was decided that the activities of the Club be resumed, and the following office bearers were appointed:—President, R. Watson, Esq.; Secretary and Treasurer, R. A. Law, Esq., 7, Queen's Gardens, Glasgow, W.; Committee, Messrs. Gray, Scott Hay, and Adcock.

The next meeting has been provisionally fixed for Monday, January 12th, notification to be sent to members later, and meanwhile the Secretary will be pleased to hear from any of those interested in wireless who care to join the Club.

* * *

The Three Towns Wireless Club.

Some months ago it was proposed by W. Rose, the Hon. Sec., that all amateurs should form a League. This was published in several American

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radio newspapers, letters were exchanged between the Radio clubs and an International Society of Radioists was formed. A relay is being formed through Canada and Newfoundland, to Great Britain. The Executive Headquarters have been fixed at Omaha, U.S.A. with the Three Towns Wireless Club as headquarters for Great Britain. The American amateurs number over 100,000, and are going to support the Three Towns Club in anything proposed or done.

November 6th—Much enjoyment was provided by the first of a series of Socials by members and friends of the Three Towns Wireless Club, held at The Lockyer Hall, Alfred Street, Plymouth.

There was an encouraging attendance, and thanks to the energy of Mr. Rose and his Committee (who organized the function) the arrangements left nothing to be desired. Mr. Lemin was M.C. Dancing and games added much to the general amusement, whilst a pleasing musical programme was submitted. The following contributed:—

A Song and Encore by Miss G. Rose. Concertina Selection by Mr. Percy Brush. Comic Song by Mr. Jerritt, Jun. Song by Mr. Canniford and a Duet by Messrs Burrows and Furneaux. Mr. Fredman was great as a Jazz Band. Mr. J. Jerritt read a letter from Lord and Lady Astor (President and one of the Vice-Presidents of the Club) expressing regret at being unable to attend owing to their recent bereavement. The Refreshments which were free, were ably dispensed by Mrs. Rose and helpers.

November 13th—The evening was spent in Morse practice and in the election of Lady Astor and Mr. E. Blake, A.M.I.E.E., Joint Editor, WIRELESS WORLD, as Vice-Presidents. Mr. J. Jerritt presided.

November 19th—The Chair was taken by Mr. J. Jerritt. The lecture was kindly given by Mr. Greenwood, R.N., on the subject of continuous waves. A simple valve transmitting circuit was shown for the benefit of members who are constructing apparatus.

November 26th—The Chair was taken by Mr. J. Jerritt. The lecture was by Mr. Lock on Accumulators and the process of manufacture was shown.

Amateurs! Why not Write for "THE WIRELESS WORLD"?

We offer amateur wireless men our standard rates for contributions descriptive of their stations, their experiments, the construction of any interesting and useful "gadgets" they may have evolved, or any matter of interest to wireless experimenters. We particularly desire good photographs of stations and club laboratories, or of club groups at work, at play, or just "posing." All clubs who would like their Officers and Committee to appear in our pages should induce them to face the camera. Send us the photographs and we will do the rest.

NOTE.—An article of fair length accepted and published by us means a new valve for you.

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The Wireless Society of London

Proceedings of the Ordinary General Meeting held at the Institute of Civil Engineers on Wednesday, November 26th, at 6 pm.

THE PRESIDENT, MR. A. A. CAMPBELL SWINTON, F.R.S., took the Chair. MR. F. HOPE-JONES, M.I.E.E., in the unfortunate absence through illness of the Secretary, Mr. H. Leslie McMichael, read the Minutes of the previous meeting, which were duly confirmed.

THE PRESIDENT then referred to the list of members and associates passed by the Committee since the last meeting and put up for ballot. A list of these was handed to each member present. The President then announced that the Committee had decided to appoint the WIRELESS WORLD as the Society's official organ and pointed out the advantages attaching to this arrangement.

MR. J. SCOTT-TAGGART then read a paper entitled "A System for the Reception of Continuous Waves," which was followed by an interesting discussion to which Mr. Scott-Taggart replied.

The meeting adjourned at 7.45 p.m. after the passing of a hearty vote of thanks to the author for his interesting paper.

A System for the Reception of Continuous Waves.

By J. SCOTT-TAGGART.

THE arrangement to be described is of interest largely because it solves in one way the problem of producing a continuous wave wireless receiving circuit capable of "stand-by" and "tuned" adjustment combining ease of manipulation and high selectivity. In addition, the circuits may be adjusted so as to reduce radiation to a negligible value. The complete arrangement was designed by the author and used for certain special artillery communications during the fighting of 1917 and 1918. As evidenced by reports, it proved of exceptional value in battle and overcame the difficulty, previously experienced, of interference by neighbouring "spark" stations. On several occasions communication was steadily maintained with a forward station 15 kilometres away, although a 2 kilowatt spark set was operating within 300 yards of the continuous-wave receiving station and working on a wavelength only slightly different.

The arrangement may be divided into three essential circuits A, B and C. The circuit B is of the usual type. An aperiodic retroactor coil L_2 is coupled to a variable inductance L_1; this coupling is made variable and if sufficiently tight will cause the circuit B to oscillate of its own accord at a frequency determined chiefly by the value of the condenser C_1. The filament of the vacuum tube V_1 is heated by a six-volt accumula-

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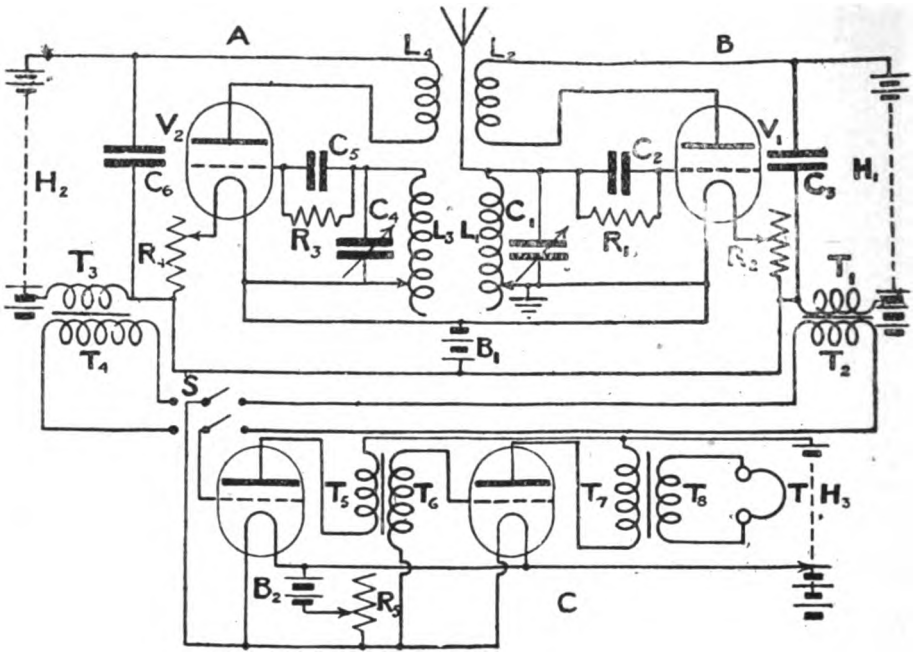

Fig. 1.

tor B_1 through a rheostat R_2 of about 5 ohms resistance. A plate battery H_1 of about 60 volts and the primary T_1 of a step-up transformer T_1 T_2 are connected as shown, a fixed condenser C_3 of about 0·0008 mfd. being connected across H_1 and T_1 in order to by-pass the high-frequency component of the plate current of V_1.

The portion A is exactly the same as B except that no aerial or earth connection is made. The filament of V_2 is heated by current from the common accumulator B_1. A double change-over switch S enables any low-frequency current supplied by T_4 or T_2 to be applied to an audio-frequency or note amplifier. C. This circuit C possesses an inter-valve step-up transformer T_5 T_6, a telephone step-down transformer T_7 T_8, a pair of low-resistance telephones T, a plate battery H_3 of 60 volts, a filament-heating accumulator B_2 and other features which will be understood by reference to Fig. 1.

The circuit A is placed near to the circuit B so that an inductive effect is obtained. The distance between A and B should preferably be variable and for eliminating interference the author has placed A as much as six feet away from B, although one to two feet is more usual.

While "listening-in," the switch S is placed over to the right and all reception is accomplished by means of the B circuit. The coupling between L_2 and L_1 is adjusted until the circuits commence to oscillate of their own accord. By adjusting C_1 the tuning of the aerial circuit and the adjustment of the local frequency are accomplished simultaneously, and signals from an external C.W. transmitting station are easily picked up. It is to be noted that signals will only be heard if the local frequency is

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either greater or less than the incoming frequency by between 100 and 4,000. Beyond these limits the beats produced will, for all practical purposes, be inaudible. By gradually increasing the capacity of C_1 continuous wave signals are first heard in T as a high note which will gradually decrease as the capacity of C_1 is increased. A silent point will ultimately be reached, and under these conditions the local frequency will equal the incoming frequency. The aerial circuit will now be exactly tuned to the incoming frequency. As the value of C_1 is increased still further, beats will once more be formed and a note will be heard which will gradually increase in pitch as the capacity of C_1 is increased, until it passes the audible limit.

The signal strength obtained on this circuit B will depend to a certain extent on the value of the coupling between L_2 and L_1, the plate voltage and the filament current. The cumulative method of grid rectification is employed, a grid condenser C_2 of about 0·0003 mfd. being shunted by a resistance R_1 of about 3 megohms. Apart from the correct choice of a suitable operating point on the grid and plate current curves, we are also concerned with the correct adjustment of the amplitude of the local heterodyning oscillations. This adjustment cannot conveniently be made, a disadvantage which is keenly felt.

It will be seen that for a beat note to be produced the aerial circuit must be slightly mistuned in order to produce local oscillation of a frequency differing from the incoming frequency. The incoming waves force themselves into the aerial circuit in spite of the fact that the latter is out of resonance. While preserving their original frequency the oscillations have their amplitude decreased and cause a loss in signal strength which is very noticeable in the case of weak signals. The higher beat notes correspond to greater disparities between the local and incoming frequencies. Consequently, a high beat note necessitates a very considerable mistuning of the aerial circuit especially in the case of wavelengths higher than about 500 metres. This fact explains why the loudest signals are invariably obtained on almost the lowest beat notes, since under these conditions the loss of efficiency due to mistuning is at a minimum. If this secondary effect were absent, the loudest beat notes would, in the case of an average pair of telephones, have a frequency in the neighbourhood of 1,000.

The advantage of rapid adjustment, while making the arrangement suitable for " picking-up " signals renders it open to serious interference from spark stations. Another very important disadvantage is that the circuit radiates while receiving. The B circuit acts, in effect, as a small power transmitter which will cause incalculable interference with other continuous wave receiving stations within a few miles' radius. It is safe to say that in nine cases out of ten, the local oscillations are far stronger than necessary. Unfortunately attempts to decrease the oscillating energy usually result in stopping the circuits oscillating or impairing the detector efficiency of the circuit.

The disadvantage of excessive jamming may very largely be overcome by tuning the oscillating B circuit to the silent points of signals, decreasing the coupling between L_2 and L_1 or decreasing the filament current of V_1 so as to prevent V_1 from oscillating, and then switching S over to the left and retuning on the circuit A which is made to oscillate. The complete arrangement now acts as if an aerial circuit were very loosely coupled to the oscillatory circuit L_3 C_4. The filament

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or plate voltage of V_1 may be dispensed with and signals will still be heard if the circuit A is tuned to oscillate at a frequency slightly different to the incoming frequency. Owing to the very loose coupling between L_1 and L_3 spark signals suffer in amplitude to a much greater extent than continuous wave signals which persist. Another advantage of the arrangement is that the energy radiated from the aerial is merely that induced by the circuit A, which is a negligible amount if the distance between A and B is considerable. The chief disadvantage of the arrangement lies in the fact that considerable inefficiency is caused by the impedance of the mistuned circuit L_3 C_1.

A further development which leads to much louder signals is to adjust the B circuit to the pre-oscillatory or sub-generative condition immediately preceding self-oscillation, by increasing the coupling of the retroactor coil L_2 or the magnitude of the filament current, which latter adjustment is preferable. The incoming continuous waves are now retroactively amplified, a phenomenon which has received scant attention as applied to continuous waves. Through the retroactive effect, which partakes of the nature of a negative resistance, the energy losses are decreased and the amplitude of incoming signals increases, much louder results being obtained in the telephones T.

The following simple procedure of tuning is recommended:—

Start with S over to the right; the coupling between L_1 and L_2 and the filament current of V_1 should be sufficient to cause the B circuit to oscillate. Tune C_1 until the incoming continuous wave signals are heard. Tune to the silent point. Now tune the A circuit (which is caused to oscillate) until a steady beat note is heard. Then decrease the filament current of V_1 until the beat note ceases; this indicates that V_1 has stopped oscillating. Now switch S over to the left and thus listen-in on the A circuit. Signals will be heard. By gradually increasing the filament current of V_1 or by the tightening of the coupling between L_1 and L_2 signals may be made much louder. The circuits are now slightly readjusted to give the best results.

It is to be noted that when S is over to the left, any alteration of the tuning of B will only affect the magnitude of the signals without altering their pitch. This is because mistuning B does not affect the *frequency* of the oscillations which force themselves into the B circuit. On the other hand, any slight alteration of the tuning of A will modify the pitch of signals.

Having now obtained signals on the A circuit let us change S over to the right. Very loud signals will now be heard without any further adjustment. The circuit A is now acting as an external heterodyning circuit which induces local oscillations into the B circuit. The relative amplitude of these oscillations may be varied very conveniently by moving A to a suitable distance from B. The variables of B may now be so chosen that V_1 acts as detector and a retroactive amplifier, but not as an oscillator. Since the circuit B is tuned to the incoming signals, the best results are not obtained when the beat note is low but when its frequency is in the neighbourhood of 1,000. It is true that the circuit B will offer impedance to the local oscillations generated by A which force themselves into the B circuit, yet any loss so occasioned is easily compensated for by bringing A closer to B; no inefficiency is, therefore, experienced.

Although the method of using the circuits just described is by far the most efficient, yet several other arrangements

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are possible. For example, the B circuit may be made to cause beats with the signals, these beats being then received on the non-oscillating A circuit.

The ratio between the amplitudes of local and incoming oscillations is of great importance and its effect will be very noticeable on the circuit under discussion which allows for considerable variations of the ratio.

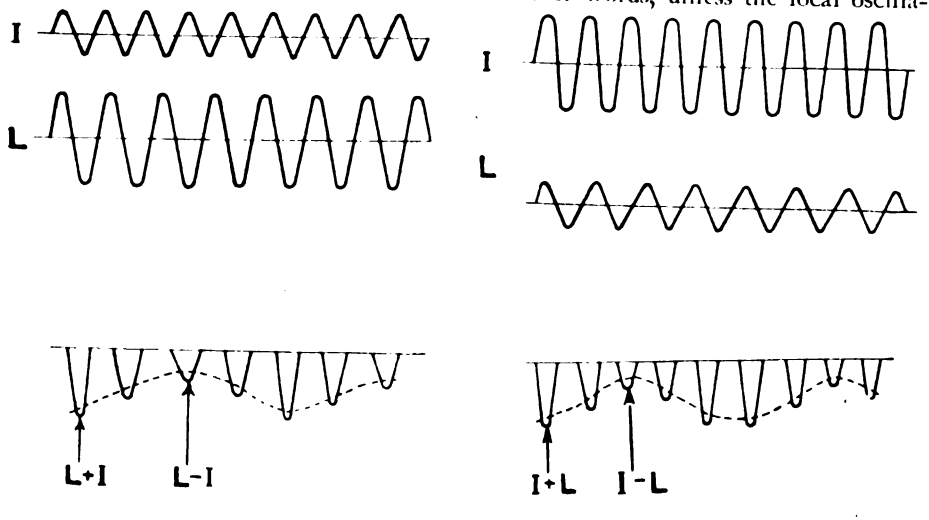

Fig. 2.

Let us suppose that the amplitude of the local oscillations is L and that of the incoming signals is I. We will readily see that the amplitude of the beats will vary from a maximum of L+I to a minimum of the difference between L and I. Suppose that L is greater than I. Then the average beat current, when rectified, will be proportional to $\frac{(L+I)-(L-I)}{2} = I$. Consequently, we can say that when the local current is greater than the incoming current the signal strength will be proportional to the amplitude of the incoming signals. A near-by continuous wave station would consequently drown a distant station. If, however, the amplitude of the local oscillations is made less than that of the incoming waves, the beat amplitude will vary from L+I to I-L. The average rectified current would therefore be proportional to

$$\frac{(L+I)-(I-L)}{2} = L.$$

In other words, unless the local oscillations are weaker than the incoming signals, the signal strength is proportional to the amplitude of the local current (Fig. 2). Consequently, a very high-power station would not give any louder signals than a weak distant station. This effect is decidedly useful sometimes to prevent excessive interference.

These theoretical observations are fully borne out in practice and many interesting facts may be deduced from circuits of the type described here.* To

* *Vide* J. Scott-Taggart, "Some Modern Vacuum Tube Circuits," *Wireless Age*, October, 1919; also J. Scott-Taggart, "Some Practical Notes on the Use of Small Power Continuous Wave Sets," *Wireless World*, April, May, June, 1919.

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determine the frequency at which circuits A or B may be oscillating, it is useful to use one of the various types of heterodyning wavemeters which have been devised*

DISCUSSION.

Dr. J. ERSKINE MURRAY expressed interest in the paper, and pointed out that it provided still another example to be added to the already almost innumerable connection schemes for valves. Since it involves the use of three circuits which have to be independently tuned, there are necessarily a number of adjustments to be made when using the apparatus. It would, therefore, appear that the set would be more particularly useful for ground stations. He was discussing it particularly from the point of view of Aircraft and Aircraft work, in which he was particularly interested. For use in aircraft the gear shown would be too bulky and would require too many adjustments as a rule to enable the average operator to manipulate it successfully, but for a ground station for communication with aircraft it would probably be very successful. He also pointed out that in the second arrangement described, when receiving on the B circuit with the A circuit operating as a separate heterodyne, from the mere fact that there is a beat note heard in the receiving telephones it is obvious that there must be some oscillatory energy forced into the aerial circuit and therefore there would be some radiation. The diagrams shown on the blackboard illustrating the effects produced by different ratios between amplitudes of the incoming and the local oscillations were also particularly interesting and gave a clear picture of what one imagines must be taking place in the circuits.

Major N. HAMILTON pointed out that the circuit apparently involved 14 separate adjustments. He also raised the query as to radiation of the heterodyne energy and enquired as to its possible magnitude.

Mr. BASIL BINYON said that it was extremely difficult to criticise the paper without having had experience in the use of the particular circuit described. It appeared to him that one of the chief points raised in the paper was the relative advantages of separate heterodyne *versus* self-heterodyne for C.W. reception, and that it tended to indicate the superior advantages of the separate heterodyne arrangement. When receiving long waves the self-heterodyne involved a very considerable de-tuning of the aerial circuit and in such cases a separate heterodyne is practically essential since the de-tuning becomes so great that the energy picked from the waves becomes very much reduced. Relative to the author's mention of dimming the valve filament in order to stop it oscillating, he questioned whether this would not be upsetting the conditions of use and possibly losing the advantages of the best conditions. It has been stated that the rectifying properties of a valve are superior when it is oscillating, but he was not altogether certain as to the accuracy of this statement. He also thought that in many cases it is better to couple the aerial circuit to the closed receiving circuit by a loose coupling in preference to the direct connection shown in the paper. He would also like to have the author's views as to the use of the note magnifier shown in the diagram in the paper for the magnification of the heterodyne note. He thought that as a general rule it was found that ordinary note magnifiers did not magnify a heterodyne note to the same extent as they did the note of a spark signal. This possibly may be due to certain resonance effects in the transformers of the note magnifier.

Mr. BROADWOOD made a few remarks relative to the magnification of heterodyne notes and to the use of a detecting valve after the inter-action of the heterodyne.

Mr. PHILIP R. COURSEY said anyone who had done any experimental work with C.W. reception would probably have used receiving coils spaced several feet apart, such as had been described in the paper. Relative to the radiation that might be expected from a separate heterodyne, it was certainly a fact that when using a crystal receiver a very considerable radiation took place when using the separate heterodyne, but when using a valve detector, as described by Mr. Scott-Taggart, the coupling required would be very much weaker and in all probability the radiation would be very considerably reduced, although it is probable that it would still be appreciable. It should be noted that the arrangement described by Mr. Scott-Taggart involved the use of no less than three separate high tension batteries. This, of course, is a considerable disadvantage, particularly from the amateur's point of view, and it raised the question as to whether it would not be more advantageous to use an ordinary high-frequency valve amplifier with a separate heterodyne coupled to the output end of the amplifier, in order to reduce the radiation. It was well known that very little energy passed back through a valve to cause radiation from the heterodyne, and Mr. Scott-Taggart had recently described a receiving arrangement based on this principle in a recent number of the *Electrical Review*† The difficulties that might be experienced with such an arrangement arise through the very feeble heterodyne power that is required, especially when using a multi-

* *Vide* J. Scott-Taggart, "Notes on the Measurement of Continuous Waves," *Wireless World*, October, 1917; "Further Notes on the Measurement of Continuous Waves," *Wireless World*, December, 1917; and "A Heterodyning Wavemeter," *Electrician*, p 243, No. 2155, Vol. lxxxiii, September 5, 1919.

† *Electrical Review*, 85, p. 614, November, 1919.

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valve amplifier, but with only two or three valves the problem is a very much simpler one and the separate heterodyne does not require a separate high-tension battery since the anode circuit of the heterodyning valve can be supplied in many cases from its own filament battery. Such an arrangement would, therefore, appear to be a much more practical one for the experimenter of perhaps limited means. The drawings made by Mr. Scott-Taggart to explain the addition of a proper proportion of the local oscillations to the incoming oscillations seemed to express the matter very clearly and to give a much more comprehensible explanation of this action than is usually given, such, for example, as the commonly quoted mathematical demonstrations that one finds in the *"Proceedings of the Institute of Radio Engineers."*

Mr. R. C. CLINKER pointed out that the paper raised the point of the measurement of the frequency of continuous waves. For this purpose an ordinary heterodyne wavemeter may be used, but it might be of interest to draw attention to a very simple method which had recently been described by L. W. Austin, making use of the click which is heard in the telephones when an oscillatory circuit coupled to the circuit of the oscillating valve is tuned to the same frequency. When the coupled circuit is gradually taken through the tuned position two clicks are heard, corresponding to the two frequencies of the coupled circuits, and by loosening the coupling sufficiently these clicks could be brought quite close together. He would like to point out that in his experience this method proves an extremely accurate one in addition to being very simple. He also made a few remarks relative to radiation from the separate heterodyne set.

Mr. BROADWOOD suggested that it would be possible to use the receiving valve only as a detector and then to pass on the rectified energy from this valve to react with a separate circuit which may be made to oscillate at an accoustic frequency and thus get a species of low-frequency heterodyne. Such an arrangement might avoid some of the difficulties of heterodyne radiation.

Mr. HOLUBOWICS enquired whether he had correctly understood Mr. Scott-Taggart's explanation of the heterodyne, namely, that the amplitude of the resultant heterodyne current was $\frac{(L+I)-(L-I)}{2} = I$

THE PRESIDENT (Mr. Campbell Swinton) said he thought he was voicing the feelings of the meeting in expressing the indebtedness of the Society to Mr. Scott-Taggart for describing this new arrangement. It was true that there are already an extremely large number of valve connections, but that should not hinder us from welcoming any new method.

Mr. SCOTT-TAGGART, in reply, said: Dr. Erskine-Murray and other speakers have pointed out that the circuits described to-night do not altogether prevent the radiation of feeble continuous waves during reception. This is perfectly true, but my point was that such radiation is almost negligible; that it was conveniently variable by altering the coupling between A and B, and that the radiation would be infinitely smaller than that produced by the simple self-heterodyning circuit, which almost invariably produces local oscillations of unnecessarily strong amplitude.

Major Binyon has raised the very subject I hoped would be discussed, namely, the relative values of self-heterodyne and external heterodyne receiving circuits. He shows an inclination to consider self-heterodyne circuits as the more preferable, provided a separate aerial circuit is used. Such a circuit is actually covered by the present paper. It is used when the indicating circuit C is connected to the A circuit, that is to say when S is over to the left, and when the filament current of V_1 is switched off. The aerial circuit now contains L_1 and C_1, the retroactor coil L not coming into action. Such an arrangement is not very efficient* if only because the A circuit is tuned to the local frequency and therefore out of tune to the incoming signals induced into A by L_1 C_1. Apart from this, however, such an arrangement cannot, and in practice does not, give the same results as when the circuit B is made to influence retroactively the incoming continuous waves. This is accomplished by increasing the coupling between L_1 and L_2 or by increasing the filament current of V_1 until the circuit B just fails to oscillate. The resistance of the aerial circuit is now considerably lessened, and the resultant signals have been found to be at least twice as loud as when my negative resistance effect is not employed. Another result of retroactively amplifying the continuous oscillations before passing them on the rectifying and heterodyning circuit A is that interference from shorter wave stations may be largely eliminated. In this case, however, an addition to the circuit is made by connecting a variable condenser across L_2.

I am afraid the use of a self-heterodyning circuit with a separate aerial circuit is not likely to find much favour in the future. In addition to the disadvantages enumerated above it is not possible to vary the amplitude ratio between local and incoming oscillations. It is certainly not possible to make the local amplitude *less* than the amplitude of average incoming signals. We thus fail to get the best adjustment and also lose the valuable effect of lessening continuous wave interference mentioned in the latter part of my paper.

* In the special case where the valve tends to oscillate at the different frequencies, the signals may be retroactively amplified by one of the frequencies and heterodyned by the other. This effect gives loud signals, but the adjustment is very critical.

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An alternative arrangement mentioned by Major Binyon, and one very freely used, consists in using an external oscillator coupled to a valve detector or detector amplifier circuit. We now get no loss due to mistuning, and the arrangement is much preferable to the self-heterodyne circuit. The conditions may be reproduced on my arrangement by switching S to the right, making the coupling between L_2 and L_1 very loose and using B as an ordinary valve detector circuit. The results, however, are nothing like as good as when the circuit B is brought to the pre-oscillatory condition and the amplitude of the incoming signals thus increased. The results are considerably better than when S is over to the left, although this latter method of receiving is itself a considerable advance on the more usual systems. It is to be noted, however, that the *selectivity* is highest when S is over to the left, although optimum signal strength is obtained with S to the right. The two valuable effects might be obtained in the one receiving system in the following manner: A separate aerial circuit tuned to the incoming frequency would be arranged. This circuit would be very loosely coupled to a retroactive circuit such as B without the aerial and earth connections and also tuned to the incoming frequency. An external oscillator such as A would now be made to induce local oscillations into B. The amplifier C would be connected to the B circuit. Major Binyon has asked whether the method I suggest for stopping B oscillating and bringing it to a suitable retroactive condition, namely, by lessening the filament of V_1, is not going to lessen the detector efficiency of V_1. It is conceivable that it would under special conditions, but, on the other hand, dimming the filament very often improves the detector efficiency by bringing the operating point to a more suitable position on the characteristic grid or plate current curve. This, for example, would be the case if the voltage of H_1 were small. I prefer the method of varying the filament current, since the adjustment does not alter the tuning of the circuit. Varying the coupling between L_2 and L_1 would, on the other hand, by varying the mutual inductance, alter the tuning of B and a readjustment of C_1 would be necessary.

The same member considers that the valve V_1 will not be such an efficient detector when not oscillating as when it is in a state of oscillation. I am aware that certain much-quoted evidence has been produced on this question, although no other evidence either way has been submitted. My own personal experience is that an oscillating valve is in no way a better detector than a retroactive valve employing an external heterodyning oscillation. The opposite has been the case.

My personal opinion is that self-heterodyning circuits have received undue praise and I think it very likely that in the future they will fade more and more into the background.

Major N. Hamilton has pointed out that about 14 adjustments are necessary. This is far from being the case, although about that number of variables have been provided chiefly to enable the circuits to be used for experimental purposes, and in the numerous ways suggested. The normal adjustments are four. That the arrangement is not unduly complicated and difficult to adjust is proved by the fact that such arrangements were worked by ordinary operators with excellent results during a rapid advance.

It has been asked whether the arrangement

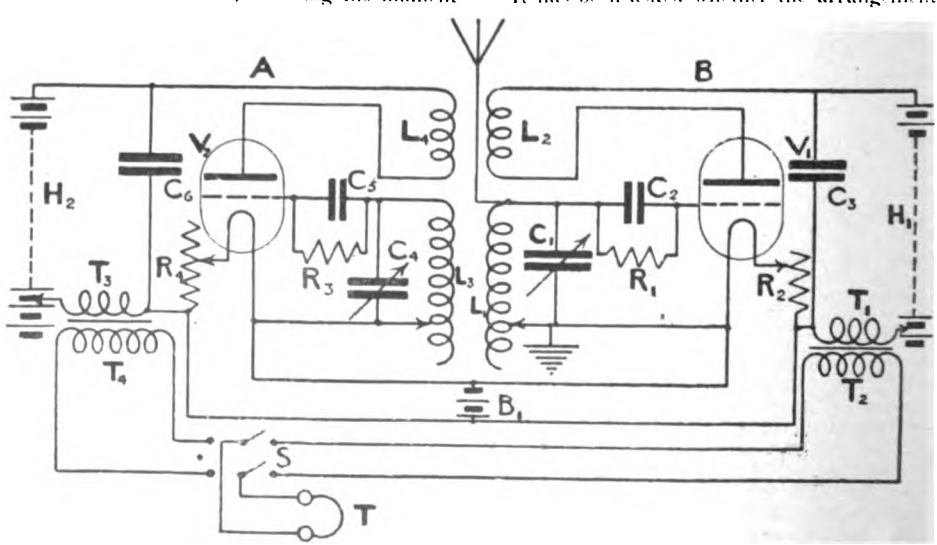

Fig. 3.

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is suitable for quick search. It is pre-eminently suitable. The preliminary search is first made on the B circuit— a very simple matter. The adjustment of the "tuned" arrangement is then very speedily accomplished by tuning A until the beat note is heard, as described in the paper.

Mr. Philip R. Coursey, amongst other remarks, suggests that the plurality of plate batteries is hardly likely to appeal to the impecunious experimenter. This is true, and the arrangement could be simplified by substituting telephone step-down transformers in place of T_3T_4 and T_1T_2 and connecting low-resistance 'phones across the middle terminals of S in place of the amplifier C. (Fig. 3.) This would, of course, considerably lessen the range of the system. It may be of help to some to point out that the same accumulator B_1 might be used to heat the filaments of the amplifier valves. Alternatively, instead of using a separate plate battery H_3, tappings might be taken from H_1 or H_2. Both a common plate battery and common accumulator cannot be used at the same time.

One of the speakers asked whether the heterodyning could not in some way be accomplished in the amplifier. This is certainly possible in the case where the amplifier has inter-valve oscillatory circuits. As Mr. Coursey has pointed out, I have described in the *Electrical Review* of November 14, 1919, a two-stage receiver which allows continuous waves to enter, but which prevents all radiation. A modified arrangement would consist in disposing an external oscillator, so that it induced local oscillations into any of the oscillatory circuits (other than those of the first valve) of a high-frequency amplifier-detector. I trust I have replied satisfactorily to the various interesting points raised, and hope that my paper will be of more value to members when in its printed form.

RECORDING OF EIFFEL TOWER TIME SIGNALS FOR DETERMINATION OF CLOCK ERROR.

CAPT. L. B. Turner, who described his valve relay before the Institution of Electrical Engineers last July has now published further information connected with this instrument, in the *Electrician* of November 14th. The experiments described are instigated by a demand for wireless recording apparatus to be used in determination of longitude for survey work in East Africa, and were carried out at the Signals Experimental Establishment, Woolwich. A double magnet chronograph was employed to obtain the records and the Eiffel Tower time signals were used. Two patterns of chronograph were experimented with, the ordinary astronomical Hilder chronograph and the Lindquist chronograph. In the former the records are made by fountain pens, while in the latter the strip is punctured by a sharp point at the beginning of each signal. The latter instrument, therefore, has particular advantages for survey work on account of the avoidance of ink.

Experiments were also performed to investigate the lag in the relay apparatus in order to determine to what extent this would effect the results. The mean of a number of experiments indicates that this lag is of the order of $\frac{1}{200}$th. of a second. It is therefore generally quite negligible. The great advantage of strip records is that they enable the proper signal record to be sorted out from the marks also made by atmospherics. With a telephone receiver this is extremely difficult in many cases, but owing to the rhythm of the signals the atmospheric trouble, unless very bad, can generally be eliminated by careful measurement of the records. An aerial 200 ft. long and 50 ft. high was used. With this the Eiffel Tower signals could be made to give as much as two or three volts on the grid of the oscillatory valve. This is about ten times as much as is essential, so that the apparatus could be used at very much greater distances from the Eiffel Tower without unduly large oscillations.

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Early Experiences of a Wireless Amateur

By W. J. Fry.

A CHAT with our friend the Editor on radio topics in general brought from his lips the remark, "How did you come to start experimenting in wireless?" Well, my desire to do so was the outcome of experiences in electrical work extending over a long period. I was seized with what I may call the short-circuiting craze when but a juvenile of the age of 10 years. A cousin of mine returning from Devonshire excited my boyish imagination by presenting me with a copy of that good old book, "Intensity Coils," by Dyer. Little did I dream in those days of the future which lay before what was then but a comparative toy, the induction coil. No Hertzian waves or Röntgen rays were manifested by its discharge. Indeed little was known of the familiar dark space in the Crookes' tube or of etheric oscillations produced by the spark of the coil.

I shall never forget my delight when I constructed my first voltaic cell of copper and zinc elements with sulphuric acid as electrolyte. I think one of my chief pleasures at the time was to watch the evolution of the gas in the cell, and the thought that current was being forced through the circuit.

My next essay in the realms of practical science was to construct two Bell receivers and a Leclanché cell; unfortunately these were inadvertently mixed up with my mother's dressmaking materials and were in consequence abruptly confiscated. Nothing deterred by this unfortunate experience my next attempt was in the regions nearer the Heaviside layer. With a pall and the use of a forty-rung ladder a No. 8 galvanised wire was stretched over the houses of the district surveyor and twelve other respectable citizens at the unearthly hour of 4 a.m. and some small attempts at telegraphy were made by means of this aerial wire.

The Author and his first Transmitter.

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By this time I had begun to appear as a full-blown electrician, and gained some experience with the engineers of the Old Gulcher Electric Light Co., at a West Brompton Exhibition. I shall never forget those old dynamos with their eight field pole-peters as they were then called, and the 8-section Gramme ring armature. Fireworks were not in it whilst these machines were working. Shortly after this my appetite for experiment was fed by the manufacture of a series Siemens' machine. At last having earned the title of Engineer-in-Charge, and having to do with electric lighting and telephone erection, I came to wireless telegraphy. My manager, who was an old Mercantile Captain, one day suggested the operation of the telephone without the use of wires. "Eh, sir," said I, "that will never be." "Never is a long day," he replied. Greatly to my surprise, not long after the Captain buttonholed me, and said, "Look here! here's something for you," and to my amazement, he produced de Tunzelmann's book on Radiotelegraphy (1902). This decided me that I should have to go in for wireless at once. Somewhere about the same date appeared Bottone's book entitled "The Amateur Electrician's Workshop," in which was an account of the construction of a coherer detector. Having now fully developed radio fever, I set to work in earnest, and the year 1902 saw the construction of my first receiver—a coherer. The one-inch coil and oscillators are to be seen on the parapet and photographs of my two Wimshurst machines are shown elsewhere. The proud radio engineer can also be seen on the parapet looking for an announcement that his signals are being received. At first a single wire aerial was dropped from a mast over the parapet (which is 90 feet high) to a depth of 30 feet and an earth lead was taken to the lightning arrester some way back, but 35 feet above the aerial.

A home-made Wimshurst machine.

Another Wimshurst machine.
"Door-knobs, sauce-bottles and pieces of old table."

On transmission no reception was registered at the receiving station. Remem-

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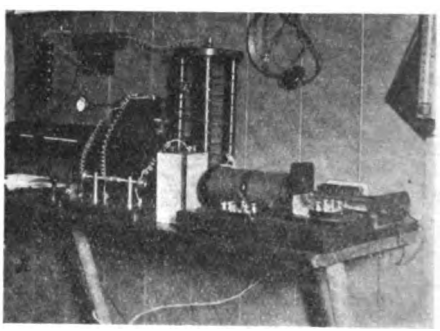
bering the story of the old man who oiled the telephone switch-hook in order to make it hum, I felt inclined to oil the aerial. Instead of this I tried nickel filings in the coherer, with no better results. Then I tried another earth, a proper earth this time, straight to the ground. Eureka! Up went the flag at the receiving station signifying that we were "through." Further experiments, using bell bronze with the coherer gave much more satisfactory results. Then came Popoff's carbon-and-needle detector with increased speed of working as a result. After this I constructed an elaborate set with a coupled inductance, four variable condensers and a Galena-graphite detector. As very often occurs with these ambitious attempts no results were at first obtainable from this apparatus and on investigating the cause the telephones were found to be incorrectly wound, and on re-winding these to 2,000 ohms and introducing the then new detector, fused silicon, excellent results were recorded. Thus were my ambitions realised, but only, of course, for the time being, because as a true radio amateur I am always looking for something better.

The two Wimshurst machines were constructed from pieces of a mahogany table, door knobs and sauce bottles, and were of great use in my lectures on the coherer receiver.

The photograph of the amateur station (belonging to Mr. Turnbull) shows



A neat amateur station.

a coupled inductance, tubular condensers and detector of my manufacture. This station was situated at Chalk Farm and used to communicate with mine at Camden Town; its signals also reached Mr. McMichael's station, MXA, at Stondon Park, using 12 watts.

AUDIO FREQUENCY AND RADIO FREQUENCY.

Alternating currents are generated at various frequencies, covering a remarkably wide range. Depending on their application, the frequencies in practical use fall into three well defined classes:

(*a*) Commercial frequencies, which nowadays generally mean 25 or 60 cycles per second.

(*b*) Audio frequencies, around 500 to 1,000 cycles per second.

(*c*) Radio frequencies, usually between 100,000 and 1,000,000, but extending in extreme cases down to perhaps 10,000 and up to several million cycles per second.

Audio frequencies are those conveniently heard in the telephone. When alternating currents are sent through a telephone, the diaphragm of the latter vibrates. The vibrations are heard as sound. The more rapid the vibrations, the shriller the tone. Vibrations at the rate of 4,000 or 5,000 per second give a shrill whistle, whilst the lowest notes of a bass voice have somewhat under 100.

Radio frequencies occur in the circuits of radio apparatus, for instance in an antenna. They are too rapid to cause a sound in a telephone, which can be heard by the human ear. They can be heard by the human ear.—(*Radio Amateur News.*)

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Aircraft Wireless Section

Edited by J. J. Honan (late Lieutenant and Instructor, R.A.F.).

These articles are intended primarily to offer, as simply as possible, some useful information to those to whom wireless sets are but auxiliary "gadgets" in a wider sphere of activity. It is hoped, however, that they may also prove of interest to the wireless worker generally, as illustrating types of instruments that have been specially evolved to meet the specific needs of the Aviator.

CRYSTAL RECEIVERS.

THE development of the capabilities of the thermionic valve as a rectifier and amplifier, and the consequent design of exceedingly sensitive multi-valve receiving-sets employing both high and low frequency amplification has rendered the crystal receiver obsolete as regards work in the air.

In the earlier days of the war, however, crystal sets, such as the R.N.A.S. type Tb, were used for reception during flight with considerable success, particularly when employed in conjunction with the Brown relay, or with valve amplifiers.

But as a land instrument for the reception of messages sent from the air, the crystal "short wave tuner" proved most successful, and remained in general use right up to the end of the war. In fact the Armistice found some thousands of these sets still on active service in and about the front line area. They were mostly employed in the reception of messages from aircraft engaged on patrol or short-range reconnaissance duties, and more particularly for recording the observations of planes working on "target spotting" in co-operation with the artillery.

The "tuner" and Wireless operator were located under ground, usually somewhere in the vicinity of Battery Headquarters, and it was their combined duty to be always on the alert. Information from the sky-patrol was too valuable to be lost through any carelessness on the part of the W/T Watchdog. Sometimes an emergency S.O.S. from the air would call for barrage fire against an unexpected infantry attack, and occasionally would come the welcome news that a "plum" target was asking for trouble at, say, B5C82 to B8d46. Or, more frequently, a petulant succession of "B's" would signify that observer number so and so of X Squadron was sitting up aloft over a certain Hun target waiting for our battery to finish breakfast and show by means of the usual ground-strip that they were ready to carry on the good work. When this was forthcoming, there would ensue a busy time for the short-wave tuner and its attendant slave, until after an uncertain spell of more or less eloquent Morsing, the aerial spotter would recollect that there was a matter that required his immediate attention in the Mess, and the "pack up" signal CI would indicate that he was going back to see the bar-orderly about it.

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Then, with some luck, the S.W.T. and operator might enjoy a little break, for crystal recuperation and mental relaxation respectively until the next R.A.F. cloud arose in the sky.

Meanwhile perhaps it will be as well to give a description of the actual instrument. It is of considerable interest as a type of receiver which was specially evolved to take the unusually short wavelengths radiated by the No. 1 Transmitter, this being the sending-set mostly used by patrol and "target spotting" planes.

As stated previously, the wavelength range of the No. 1 varied between 100 and 300 metres. Specified wavelengths were allotted to adjacent squadrons, and to the component flights of each squadron within these limits. For example the three flights of one squadron would employ lengths of, say, 140, 180, and 220, whilst to the adjacent squadron would be allotted the lengths 160, 200 and 240.

Bearing in mind the number of planes that might be operating simultaneously over a busy area, and the extent of overlapping that was bound to ensue in the areas of active operation allotted to each squadron, it is not difficult to realize that a receiver employed on such work must be an efficient instrument, reliable in operation under the unfavourable conditions inseparable from actual warfare, and capable of a high degree of selective tuning in face of the extraordinary amount of jamming through which it must be able to identify and follow the particular bus with which, for the time, it is working.

ACTION OF THE CRYSTAL RECEIVER.

As a preliminary it may be useful to summarize shortly the general theory of reception by such a set.

The open or aerial receiving circuit responds to electromagnetic disturbances travelling through the ether, the impact of such waves setting up corresponding variations of e.m.f. (and consequently an alternating current flow) in that circuit. The energy so transferred from the ether to the circuit will be a maximum when the induction and capacity values of the latter are adjusted so that its natural period of electric oscillation synchronizes with the periodicity of impact of the ether waves. When so adjusted the aerial circuit is said to be "tuned" to the given wavelength, and the impact upon it of the series of damped electromagnetic waves radiated during the time-interval of one spark-passage at the transmitter creates a corresponding series of damped e.m.f. variations, each of which forces a small uni-directional current surge through the one-way channel afforded by the crystal, the cumulative effect of these surges being sufficient to give rise to one click in the phones for each spark at the transmitter. It follows therefore that if the spark frequency of the transmitter is, say, 300 per minute, this frequency of "clicks" will be recorded by the receiver telephone and will determine the pitch of the signal note received.

The detector may be placed directly across the open circuit, in which case it is sensitive to all energy impulses received by that circuit and is said to be on the "stand by" position.

Or the energy flow existing in the open circuit may be first transferred inductively to a closed circuit, across which the detector is then placed. This cuts out extraneous disturbances existing in the open circuit, the arrangement being equivalent to a kind of filter which excludes wavelengths other than those to which it is tuned. Such disturbances may exist in the open circuit, but, being relatively weak, are eliminated in the process of inductive transfer between the circuits.

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The detector when placed across the closed circuit gives selective tuning, and is said to be in the " tune " position.

SHORT-WAVE TUNER (Mark III)

GENERAL.

With a standard 125-foot ground aerial of R4 seven-stranded wire arranged as a single inverted L, wavelengths varying from 100-700 metres can be received on this instrument.

A photograph of the set is shown in Fig. 24, whilst the complete wiring arrangement is shown in Fig. 25.

The detector circuit can be placed either on " stand by " or " time " by means of a change-over switch.

Either a Perikon or carborundum crystal can be used at will, a potentiometer circuit being included with the latter so that the carborundum may be adjusted to the point of maximum sensitivity.

Provision is also made for calibrating and testing the circuits by means of a buzzer, which is automatically inserted in the closed circuit when the detector is used across the open-circuit inductance (i.e., when on " stand by ") and is similarly thrown into the open circuit when the detector is across the closed circuit (i.e., on " time "). In both cases the buzzer is inoperative until a special key is closed.

It will be seen from the wiring diagram that the closed circuit is normally broken at K when on " stand by," in order to prevent any transfer of energy between the open and closed circuits, and consequent weakening of signal strength received. For the same reason and as an additional precaution it is advisable, when searching for weak signals on " stand by," to keep the capacity and inductance of the closed circuit at a minimum and the coupling at " loose." In order that the buzzer may operate in this gapped circuit, a key is provided which (a) closes the buzzer circuit, and (b) simultaneously through the insulator block L, shorts the two " gap " leads from the closed circuit.

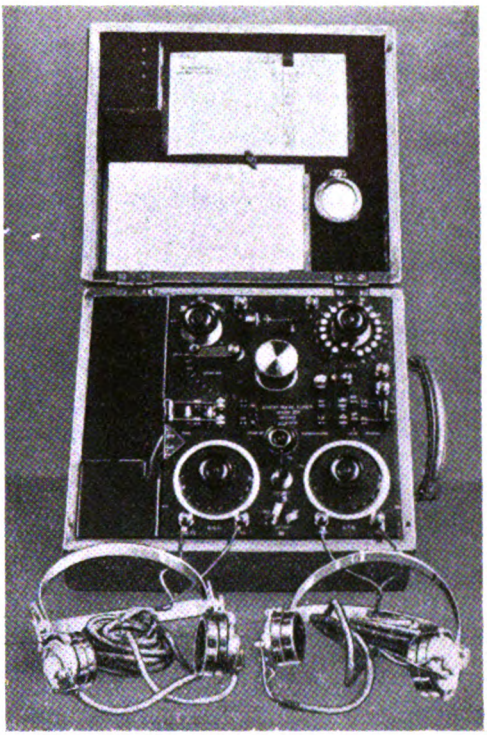

Fig. 24.

Having thus broadly surveyed the characteristic features of the set; it may be of interest to describe in brief detail the main circuits involved.

THE BUZZER CIRCUIT.

This consists of a small shunted buzzer fed from two of the four dry cells forming the potentiometer battery. The circuit is normally open, but is brought into action by depressing a small lock button switch, which, as previously explained, simultaneously shorts the "gap" in the closed circuit. The buzzer is used to test and calibrate the circuits,

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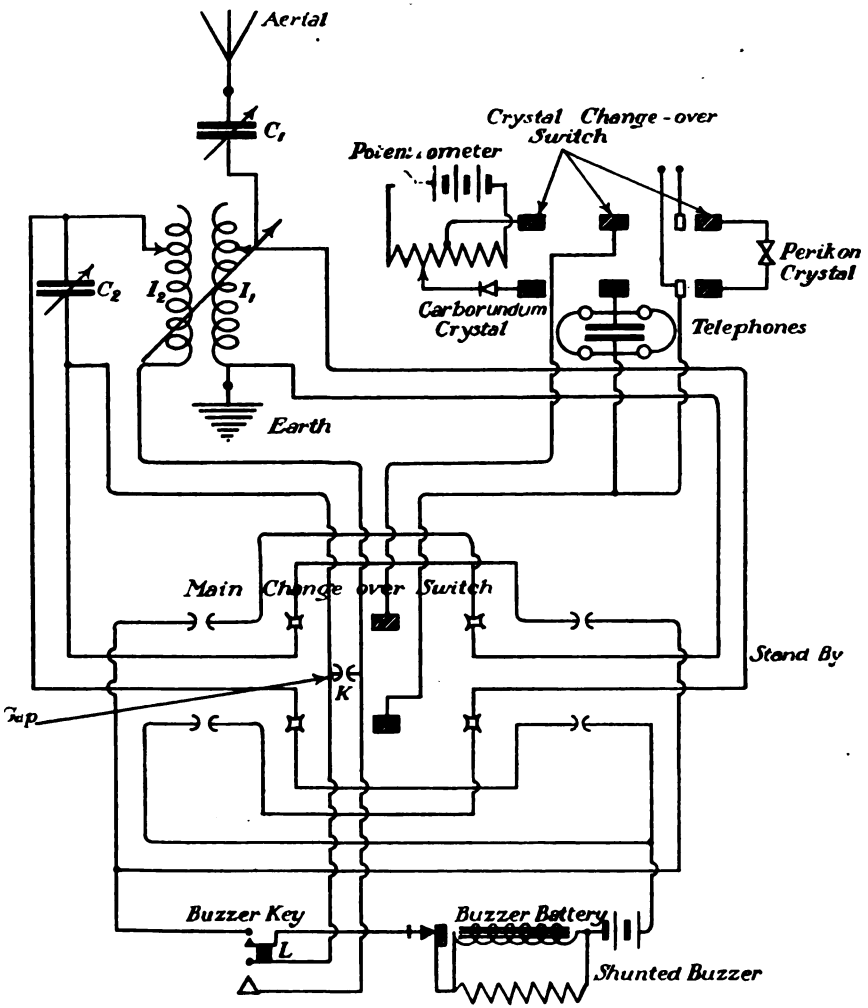

Fig. 25.

and to adjust the crystals to maximum sensitivity.

In testing the crystals, the main switch should preferably be on "stand by" so that the crystals are placed across the closed circuit, this being more constant than the open. The coupling should be "loose", and the two main circuits set out of tune in order to reduce interaction effects to a minimum.

The phones should similarly be tested by means of the buzzer, and the earpiece adjusted for maximum sound.

(To be continued.)

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Aviation Notes

THE TREND AND DEVELOPMENT OF CIVIL AVIATION.

POST-WAR commercial flying was officially inaugurated on the 1st of May of this year. In a recently issued synopsis of the progress of work in the department of Civil Aviation, Major-General Sir F. H. Sykes sets out an account of the steps that have been taken under the aegis of the Government to develop and encourage the latest transport service, and reports the progress that has been made during the initial six months of its existence.

General Sykes has faith in his work. He does not lack foresight, and acknowledges frankly the many difficulties that bar the path of progress, but he is soundly optimistic of the future, and has sufficient courage to look boldly ahead and discern final success. Reliability, safety, comfort, and economy must all be vastly improved before Aviation can play its proper part in the development of civilization. A formidable list of problems certainly, but much progress has already been made, and the remaining difficulties are not insurmountable.

* * *

THE AERIAL WAR-ARM.

A feature of the general position that should not be overlooked lies in the fact that a fully developed Commercial Air Service will constitute the main reserve of strength from which the Royal Air Force of the future will draw in time of need. Our War Air Fleet should be capable of rapid and extensive expansion, as well as of the rapid assimilation of large numbers of personnel and quantities of material at short notice. As the Mercantile Marine reinforced the Navy during the War, so it is to be hoped will civilian aviation form a valuable auxiliary to the Royal Air Force should a time of crisis arise. This source of supply can only be satisfactory and adequate if our commercial air fleet is in itself a healthy and well-developed factor. This entails the growth of a steady demand for quicker communication, built up on a reliable and adequate Air Service.

* * *

CARRIAGE OF MAILS.

The carriage of mails, as has already frequently been pointed out, promises to form one of the most important and regular demands to be supplied by civil aviation. More than any other service at present, it could be utilized as a means for placing aerial transport enterprises upon a firm footing.

The Postmaster-General, it would seem, is doubtful whether the demand for express mails between the more distant towns in the United Kingdom is likely to be sufficiently extensive to meet the considerable expense of running such a service for mails only. But if commercial services were established for passengers and small goods, he would seize the opportunity to utilize them for the despatch of express letters under suitable subsidy.

A more promising line of development for aerial mails would seem to be more along the Continental and Imperial routes where the long distances give more pronounced scope for the element of speed.

* * *

THE QUESTION OF SUBSIDY.

Whilst he considers it a vital matter that civil aviation should grow and pros-

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per, General Sykes recognizes that the new industry is hardly as yet able to stand on its own feet. He suggests three methods of assisting it: (a) By means of direct Government subsidies, as in France, where already 18,000,000 francs have been earmarked for this purpose. (b) By recognizing that *at the beginning* the British aircraft must, in order to ensure its persistence, be afforded some form of direct Government assistance, no matter how foreign this may be to usual British practice. Such aid might reasonably take the shape of a specified subsidy to approved aerial transport companies on the basis of mileage flown and weight carried. (c) By generous assistance in material and information; for example the provisions of certain "key" aerodromes and shed accommodation at home and on the Empire routes. Also the collection and distribution of meteorological and other data, and the provisions of an adequate communication system.

* * *

INTERNATIONAL FACILITIES.

Pending the coming into operation of the International Air Convention, temporary agreements have been concluded with Belgium, France, Holland, Italy, and Portugal, while permission for individual flights has been obtained from Denmark, Spain and Switzerland. Steps have since been taken which it is hoped will ensure the subscription of Holland, Spain and Switzerland to the Convention at an early date, and subsequently of the Scandinavian Countries, so that one code of rules for the air will be in force throughout Europe.

Every possible assistance in this direction has been given to those firms to whose enterprise are due the existing services between London and Paris, London and Brussels, and London and Amsterdam.

PROGRESS ACHIEVED.

As to the practical results obtained within the period of time covered by General Sykes' report, the following approximate figures have been voluntarily furnished by certain of the firms actually engaged in civil air traffic to indicate the extent of work carried out. In view of the mileage covered, the number of accidents must be regarded as remarkably small:—

No. of hours flown	4,000
No. of flights	21,000
No. of passengers carried	52,000
Approximate mileage ...	303,000
Total accidents	13
No. of fatal accidents ...	2

Both of the fatalities occurred to pilots. In no case was the life of a passenger lost.

It will be noticed that the great majority of the flights were of short duration. Mainly, no doubt, they were of the seaside joy-ride variety, and are to be regarded as of an educative character. But in view of the fact that the most fertile source of accident is in "taking off" or "landing," the proportion of accidents to "flights made" is a truer guide than that for "hours flown." The figures certainly demonstrate the importance that the firms concerned place upon the maxim of "safety first" for the flying public.

* * *

THE WIRELESS ASPECT.

The importance of wireless as an auxiliary to aviation has been fully realized. Considerable attention has been given to the improvement and increasing scope of wireless telegraphy and telephony, as well as to the perfecting of directional wireless as a means of aerial navigation. Wireless stations have been erected at Hounslow and Lympne, and wireless liaison has been established with the French for the purpose of the London-Paris air route.

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The Library Table

TEXT BOOK ON WIRELESS TELEGRAPHY.

By RUPERT STANLEY, B.A., M.I.E.E. (London: Longmans, Green and Co., two vols.: pp. xiii+471, and ix+357, price 15s. each).

THIS book was originally written in 1914 as a single volume, but with the recent rapid growth of wireless work the author has found it necessary to issue the new edition in two volumes. In this way the original layout has been very largely retained in the first volume, while the modern developments of the hard vacuum tube are extensively described in the second.

As compared with the original book, the first volume of the new edition contains additional chapters entitled "Synchronous, Asynchronous, and Resonance Sparking—Faults in Transmitters" and "Secondary Cells and Batteries," while other rearrangements of the matter have been made—notably in the order of treatment of some of the parts, and in the dividing up of old chapters into two new ones—*e.g.*, the chapter on "Capacity and Induction effect," is now divided into two. The appendices have also been modified. In place of the list of British coast stations a short combined British and foreign list has been given with the names and call letters of the most important and high-power stations in the northern hemisphere—but mainly in Europe; in addition a list of the international initial call letters allotted to various countries is also given. The extracts from the International Radiotelegraphic regulations have been omitted from the new volume, as have also the particulars of the Eiffel Tower time and weather signals. In their place a Table of Trigonometrical Ratios is given. There is one thing to be said in favour of this change—that trigonometrical functions are permanent (unless perhaps Einstein or some other mathematician finds out that they are only relative) whereas the Eiffel Tower signals, and especially the weather reports are subject to change.

As far as the general scheme of the work is concerned little can be said—the original was good, the new is equally good, or rather better, while most of the few errors in the original have been corrected.* A word may perhaps be said about page 191. In discussing the use of step-up transformers for small (experimental, etc.) stations operated directly from the A.C. mains, the author refers to transformers as made by various American manufacturers and quotes 1914 prices for them. It is altogether questionable to what extent such a practice is desirable for a text book, as although it is very useful in, say, a constructional article in an experimenter's periodical to give the amateur some idea of the cost of his apparatus, such figures are practically valueless in a text book that presumably will be used for more than a year or two.

The chapter on "Some Measurements in Radio-telegraphy" has been very considerably revised, and a quantity of useful and very practical information has been incorporated. This information is in a form particularly useful for the experimenter, since not only are the methods described, but practical details are given by which the amateur can con-

* That on p. 105 (Vol. I.) relative to the material of spark gap electrodes has, however, been passed over.

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struct and carry out such tests himself—such for example as the wavemeter windings given on p. 414. The method of measuring the effective resistance of the aerial, described on p. 421 is, however, somewhat crude, and no mention is made of the effect of losses in the condenser and inductance of the dummy aerial, although at times these may occasion a serious error in the results.

Volume II. although incorporated as part of the whole text book, is arranged in such a manner that it can well be considered on its own merits, and provides a good account of modern valve practice. It opens with a chapter on "Electrons," in which a good deal of the material already dealt with in Chapter II. Vol. I., is again passed in review as an introduction to the processes taking place in valves. Parts of this, however, relating to the constitution of the elements in the Periodic table, although making interesting reading, are not so relevant to the matter under discussion, as is the remainder. The mode of operation of a valve, and the theory of the modern "hard" valve are extensively dealt with in Chapter II., the explanations being illustrated with actual characteristics of "French" valves, in preference to the imaginary characteristics so commonly given in this connection. An extensive and interesting collection of characteristics of French and other valves is also given in Chapters IX. and X.

The "detector" action of the valve is discussed in Chapter III., and high-frequency amplification in Chapter IV.

Up to this point very little mathematics has been introduced, but in Chapter V. on the Valve as a Generator of Oscillations, the mathematical theory of the production and maintenance of oscillations is given. A knowledge of differential notation is assumed. Most of this material is particularly valuable and contains the results of the most recent work on these lines.

The next two chapters describe a number of circuit arrangements for low-frequency and high-frequency amplifiers respectively, while Chapter VIII. deals with heterodyne reception and with the relative advantages of self- and separate-heterodyne—here termed Autoheterodyne and Ultra-heterodyne respectively.

Hull's Dynatron and other patterns of special American valves are described in Chapter XI., and the mathematical relations of the former are given from Hull's *Institute of Radio Engineers'* paper. Various C.W. and Radio-Telephone Transmitters and receivers are well described in the three following chapters, which are followed by a brief résumé of other forms of radiotelephone transmitters.

Chapter XVI. strikes a different note to the remainder of the volume. It describes various arrangements for earth current signalling, and in particular the developments of this method of communication that have taken place under the stimulus of trench-warfare and similar stringent requirements.

The book concludes with descriptions of miscellaneous valve apparatus—C.W. wavemeters, valve telephone repeaters, "tonic-train" transmitters and similar arrangements of a special nature. It would appear that the second volume in particular should be eminently suitable not only for students, but for the radio-engineer as well. Both volumes are very well printed and the diagrams and illustrations clear, while each has a separate index. The author's practice of putting a few questions at the end of each chapter has been adhered to in both volumes. These questions are intended mainly for the student for self-examination, rather than as ordinary examination questions or problems.

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The Construction of Amateur Wireless Apparatus

This series of articles, the first of which was published in our April number, was originally designed to give practical instruction in the manufacture of amateur installations and apparatus, and arrangements had been made with Marconi's Wireless Telegraph Co., Ltd., to supply complete apparatus to the designs it was intended to detail. The restrictions on amateur work, however, remained in force, and the author was compelled to proceed on general lines only. A further series will be published giving the class of information originally intended.

Article Ten.—HIGH-TENSION SUPPLY.

IN our last article we made some suggestions to assist the amateur over his difficulties in obtaining a supply of current at a high voltage without rendering the cost prohibitive. This question is undoubtedly one of the most serious the average experimenter has to face when he commences his work with the three-electrode valve, and the discovery of a simple and cheap form of supply would form a very suitable field of investigation. By the solution of this problem—more particularly in the case of receiving valves—the amateur could render very valuable aid in the development of wireless telegraphy.

The actual power required for the operation of a receiving valve is very small indeed, being only of the order of $\frac{1}{10}$th. watt. The difficulty lies in the fact that this energy *must* be delivered at a high voltage. Very small motor generators have been suggested for this purpose. The motor could be arranged to run from a four or six volt accumulator battery, in fact there is no reason why the same accumulator should not be used for lighting the valve filament and supplying the current for the motor generator. The main trouble in this arrangement is due to the fact that it is difficult to make a small generator which will give a sufficiently uniform voltage at the brushes, with the result that noises are caused in the telephones. These generator noises are due to

(1) Ripples caused by the teeth on the armature.
(2) Slight sparking at the brushes.
(3) Microphonic contacts between the brushes and the commutator bars.

Ripples due to the armature teeth are difficult to suppress in the machine itself, but can be considerably reduced by the use of smoothing out chokes and condensers as described in the last article. In any case such ripples do not interfere to a great extent with reception, provided of course that they are not too strong, because the sound produced in the telephones is a continuous hum, through which it is found in practice quite weak signals can be read. This is particularly the case if the note produced by the ripples is not of too high a pitch.

Noises due to sparking at the commutator are most difficult to eliminate. The sparks result in the radiation of highly

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damped short waves from the machine itself, and these impulses cause the tuned circuits associated with the valve receiver to oscillate with the frequency corresponding to the wavelength to which they are tuned. Since these impulses are actually radiated it is sometimes possible to reduce their effect considerably by completely enclosing the generator in an earthed metal box. A large condenser connected across the brushes is also effective. In any case it is most essential that the design and adjustment of the machine should be such that there is no visible sparking at the commutator.

Microphonic action between the brushes and the commutator bars can be reduced by the smoothing out circuit previously mentioned. It is necessary that the commutator should be kept clean and that the brushes should be a good fit on it. If the brushes have not the same radius of curvature at the working face as the commutator, sparking and microphonic contacts may be introduced under the surface of the brush in which position the sparks may not be visible.

Noises are also often introduced by the motor driving the machine. Great care should be taken to secure sparkless commutation here as in the case of the generator. If the fields of both machines are fed from the same low voltage battery, any impulses produced by the motor armature may be reproduced in the generator voltage owing to fluctuations in the intensity of the fields. It is partly for this reason that the generator is often fitted with a permanent magnet field. This renders the machine more bulky because the intensity of the flux produced by a permanent magnet is very much less than in the case of an electromagnet. It should also be noted that the shafts of the two machines should be joined by means of an insulating coupling of some type, the machines themselves being mounted up on a bedplate of stabilite or other insulating material. It is essential that they should be kept quite separate electrically.

It has also been suggested that a thermopile would form a very convenient means of generating the necessary current for the plate circuit of the valve. No batteries or acid are required and there are no moving parts, the current being generated directly from the heat of a lamp. The difficulty in this case lies in the fact that the E.M.F. generated per couple is very small. For example, in the case of a copper-constantan couple, if the hot junction is maintained at a temperature of 300 degrees Centigrade hotter than the cold junction, the E.M.F. per couple is only of the order of one hundredth of a volt. The experimenter will thus see that a large number of couples will have to be connected in series to give the desired E.M.F. If any means can be devised for making the couples automatically in large quantities and to occupy a small space the idea might be worked out.

The above notes are offered with a view to giving the amateur a line which might be developed and which would be of immense importance in practical wireless if the problem could be satisfactorily solved. Much valuable information has been the result of amateur work prior to the war, and now that the restrictions are being gradually relaxed there is much useful new work for the experimenter to take up.

Before we leave this subject of the high tension supply there is one simple way of running both filament and plate circuits from one supply to which we will refer. An application of the idea is illustrated in Fig. 1, the circuit in this case being that of an independent heterodyne. The oscillating circuit A consisting of an inductance shunted by a vari-

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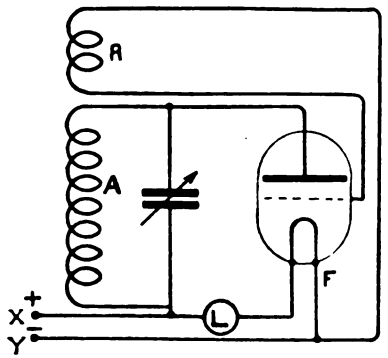

Fig. 1.

able condenser is connected in the plate circuit of the valve. X and Y are the terminals of a supply at a voltage suitable for the plate circuit of the three-electrode valve. A lamp of the correct candle power to pass the right current for lighting the valve filament is connected as shown in the *positive* lead of the supply, the filament being in series with this lamp. Such a lamp can easily be found by selection from a number of different voltages and candle-powers. The average valve filament takes about half an ampere to run it at normal brilliancy. The filament can, in this way, be lighted from the high-voltage supply and the accumulator battery is dispensed with. The plate circuit of the valve is connected to the positive terminal of the supply, and the grid is connected to the negative terminal *via* the reaction coil R. The action of the circuit can be understood by the aid of an example. Suppose that the amateur has available 110 volts direct current. Now the valve filament will probably take about half an ampere at four volts. A 110 volt 16 candle power lamp will pass about the right current to light the filament. As soon as the circuit is closed the E.M.F. will be distributed in the proportion of four volts across the filament and 106 across the lamp. Since now one leg of the filament is directly connected to the negative terminal of the supply and the plate is connected through the oscillatory circuit A to the positive terminal, we shall have the full 110 volts acting between plate and filament; and the grid will be, as usual, at the potential of the negative end of the filament. The potential conditions are therefore normal, and the circuit will oscillate if a correct adjustment of the reaction coil R is made. Of course it is necessary to choose a valve of such a design that the supply voltage is suitable for application to the plate.

The amateur will easily be able to work out for himself the necessary circuits for the application of the idea to the schemes of connections which have been given in previous numbers. The protecting fuses, etc., should always be included as before indicated; for simplicity's sake we have not shown them in Fig. 1. The arrangement will be found more suitable for high-frequency magnification than for note amplifying circuits. There is always more difficulty in silencing a note amplifier when operated from a machine-fed supply.

AMATEURS, PLEASE NOTE !

Do you belong to a Wireless Club? If not, you are probably not pulling your weight. What amateurs in this country need is a strong club movement backed by an affiliation. We shall be pleased to give you information about the clubs in your district, or to assist you in starting one.

If you wish to see Amateur Wireless win a dignified footing, join a club, help a club, or make a club.

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Questions and Answers

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless telegraphy. Readers should comply with the following rules:* (1) *Questions should be numbered and written on one side of the paper only, and should not exceed four in number.* (2) *Queries should be clear and concise.* (3) *Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before.* **(4) The Editor cannot undertake to reply to queries by post.** (5) *All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or if so desired, under a "nom-de-plume."* **(6) Readers desirous of knowing the conditions of service, etc., for wireless operators will save time by writing direct to the various firms employing operators.**

A.G. (Bayswater).—The British School of Telegraphy, 179 Clapham Road, S.W. The East London Wireless Telegraph Training College, 172a and 228 Romford Road, Forest Gate, E. Both of these Schools hold evening classes.

W.J.H. (Kirkham).—Write to Secretary, G.P.O. He will probably let you know the nearest examination centre; and his Handbook for Wireless Operators contains the fullest details of the examination.

H.S.H. (Bristol).—The design of static frequency raisers is to a certain extent the manufacturers' secret and very little is published on the details of the subject. However, refer to Dr. Fleming's well-known manual of Radiotelegraphy, Dr. Eccles' "Wireless Telegraphy and Telephony" and Zenneck's book on Wireless.

W. R. Clark.—(1) We should think you are well qualified to instruct. (2) No certificates are *necessarily* required, the posts being given to men of the best experience and greatest efficiency. (3) There are no official regulations governing the matter unless you refer to instructorships under government control, such as in the Army or Navy. The only certificate of recognised value is issued solely by the Postmaster-General. (4) This question, therefore, does not arise.

W.J.T. (Co. Armagh).—Please see reply to "Constant Reader" in the Dec. number.

W.H.R. (Horsforth).—"The Thermionic Valve and its Developments in Radio-Telegraphy and Telephony," by J. A. Fleming, D.Sc., and "The Oscillation Valve: The Elementary Principles of its Application to Wireless Telegraphy," by R. D. Bangay. For telephony you might read "Telephony" by Alfred N. Goldsmith. The Wireless Press has published a book on Wireless Telephony by Mr. Philip R. Coursey. (2) Yes, the International Correspondence Schools have such a course.

C.L. (British Rhine Army).—To qualify for the Mercantile Marine War Medal you must have served at sea for at least six months between August, 1914 and November 11th, 1918 and, in addition, at least one voyage through a danger zone during that period.

"PITCH," (Devon)—(1) Pitch would make suitable lining for wooden cases for cells providing there was no crack in the surface to allow any of the electrolyte to leak through.

(2) You do not seem to understand the ordinary secondary cell. You cannot make a plate positive on one side and negative on the other. In the simple secondary cell are two lead plates in sulphuric acid. When a current is passed through the cell, that is when they are charged, one plate becomes coated with lead peroxide while the other remains unaltered. Then when the cell is connected to a discharging circuit a current will flow in the circuit due to chemical action in the cell.

Now any number of plates can be connected up in the cell, but one-half must be connected to the positive plate while the other half is connected to the negative plate. This increase in the number of plates does not increase the *voltage* of the cell, but allows a greater current to flow owing to the greater surface of plate exposed to the electrolyte and consequently a lowering of the resistance of the cell. Hence if more than 2 V. (the average E.M.F. of a secondary cell) are required, it is necessary to connect separate cells in series. From your sketch it seems that you expect your arrangement of plates to give you 10 V.

A mixture of litharge and sulphuric acid for the negative plates, and a mixture of red lead and sulphuric acid for the positive plates is now generally used.

G.L.R. (Cornwall).—(1) It is quite true that trees can be used as receiving aerials. This is because a tree acts to a small extent as a conductor of electricity, and when the electro-magnetic waves of a transmitting station come into contact with the tree a very feeble

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current is induced in the tree. The tree has, of course, a very good earth connection through its roots, but is in itself a bad conductor.

General Squier, of the United States Army, first utilised trees as receiving aerials about 15 years ago, and has recently carried out further experiments with them.

(2) Owing to their comparatively high resistance only the modern valve receivers are of use in detecting the feeble induced currents, the valve receiver being tapped off the tree trunk.

"RADIO" (Kensington).—(1) The natural wavelength of an aerial 90 feet long with a down-lead 10 feet long, is approximately 400 feet, or roughly, 120 metres.

(2) It would be quite a simple matter to receive a station with this aerial 90 feet high, but how do you arrive at a 10-feet down-lead?

(3) The apparatus you mention is sufficient for receiving purposes.

(4) It is quite impossible for us to give you any figures for the aerial tuning inductance, as you do not mention to what wavelength you wish to tune your aerial.

"IMPATIENT" (Braintree). — (1) The blocking condenser across the secondary of a telephone transformer is still used with some receivers. It is often left out of diagrams of connections for the sake of clearness, and because it is not an essential part of a receiver. It is used in order to tune the note frequency of the received waves and is usually adjusted by the operator to suit himself.

(2) You make no mention of what you believe are the values of your inductances for the various wavelengths you receive. We suppose you worked these out when you originally wound your coils, or or did you do this by experiment alone? The inductance required with a capacity of .00003 mfd. to receive 600 m. is roughly 3,380 mhy., and that requried for 2,500 m. is 58,500 mhy., and it seems to us quite possible that your circuits were not properly in tune in your original arrangement.

Have you a wavemeter? If so, why not buzz the circuit and measure the wavelength with the wavemeter. If you do not possess one we strongly advise you to make one as you will find it most useful.

(3) The reason you get signals from loud stations with your earth lead disconnected is probably due to a capacity leak to earth, that is a leak from your secondary circuit through the telephones and yourself to earth.

W. R. B. (Birmingham).—It is quite true to say that the earth acts as a magnet with its N. pole at the South geographical pole, and its S. pole at the North geographical pole.

If a magnet is suspended so that it can rotate in a horizontal plane, it will take up such a position that its N. end will point to the geographical North, and the other end will point to the geographical South. This is of course in accordance with the "First Law of Magnetism."

It must be remembered that the end of the magnet marked N. is the "North (geographical) seeking end."

The writer has always advocated the view that it would be more convenient and logical to mark the North-seeking end of a magnet as +

The magnet with which you made your test has evidently had its magnetisation reversed, thus causing its North-seeking end to point to the South geographical pole.

H.M. (Warrington).—(1) Full particulars of the P.M.G. examination may be obtained from the Secretary, G.P.O., London.

(2) Apply to Marconi's Wireless Telegraph Co., Ltd., Marconi House, Strand.

(3) Apart from the firm you mention, there are very few employers of wireless operators in this country. You might try Siemens Bros., or, better still in your particular case, one or other of the Railway Companies who run wireless installations in connection with cross-Channel services.

"SPARKS, R.N."—Questions (1) and (3). Apply to the Secretary, G.P.O., London. (2) The fee is 5s. (4) Transmission, reception, fault-tracing, thorough knowledge of apparatus and its wiring diagrams, and rules for working traffic. Get the P.M.G.'s Hand-Book and Hawkhead's "Technical Instruction for Wireless Telegraphists" (The Wireless Press, Ltd.)

B.C. (Southport).—Please see Note 4 at the head of these columns. The Liverpool Wireless Telegraph Training College, 27, Leece Street, Liverpool.

The reply in our last issue, which was headed "Constant Reader," should have been referred to W. J. T. (Co. Armagh).

PATENTS, Inventions, Trade Marks.—Advice and handbook free.—King's Patent Agency, Ltd., 165, Queen Victoria Street, London, E.C.4.

TECHNICAL BOOKS. Second-hand and New Books on every conceivable subject. Catalogue free. State wants. Books sent on approval. Books bought.—FOYLE, 121/125, Charing Cross Road, London.

LEARN DUTTON'S 24-HOUR SHORTHAND; booklet free.—DUTTON'S COLLEGE, Desk D101, Skegness.

WANTED. The following number of "WIRELESS WORLD"—March 1918. Fair price. P. G. THOMASON, Hazel Road, Altrincham.

MR. R. J. SOWTER, B.Sc., A.R.C.S., Barrister-at-law and Fellow of the Physical Society, an Examiner in H.M. Patent Office, has been appointed by the Admiralty to the R.N. School of Signalling, Portsmouth, as Head of the Patents Section.

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Company Notes

MARCONI'S WIRELESS TELEGRAPH COMPANY, LIMITED.

NEW CAPITAL ISSUE.

EXTRAORDINARY GENERAL MEETING.

An EXTRAORDINARY GENERAL MEETING of Marconi's Wireless Telegraph Company (Limited) was held on November 28th, at the registered office of the Company, Marconi House, Strand, for the purpose of confirming as a special resolution the resolution passed on the 13th inst., providing for an increase in the capital. Mr. GODFREY C. ISAACS (deputy-chairman and managing director) presided. The other directors present were Messrs Henry W. Allen, F.C.I.S., William W. Bradfield, C.B.E., Maurice A. Bramston, Alfonso Marconi, and Sidney St. J. Steadman.

The SECRETARY (Mr. H. W. Corby, F.C.I.S.) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen,—This is an extraordinary general meeting for the purpose of confirming the resolution to increase the capital of the company, which was passed unanimously at the meeting on the 13th of this month. Before submitting the resolution I would remind you that on that occasion I said I felt sure this country would soon wake up to the necessities of the times, and eventually would demand, and the Government would recognize, that it requires the latest and best possible chain of wireless stations. I added, "when the day comes, and it may be very soon, we propose to be ready."

You will have read in the Press that the Secretary of State for the Colonies, as Chairman of the Imperial Communications Committee, has, with the approval of the Cabinet, appointed a Committee to complete a scheme of Imperial wireless communications in the light of modern wireless science and Imperial needs. That Committee has to decide what high power stations it is desirable on commercial or strategic grounds that the Empire should ultimately possess, to prepare estimates of the capital and annual costs of each station, the life of the plant and buildings as taken for the calculation of the depreciation to include an adequate allowance for obsolescence, to examine the amount of traffic and revenue which may be expected from each station, and to place the stations recommended in their order of urgency. These are the terms of reference.

APPLICATION FOR LICENCES.

When these informations are in the possession of the Cabinet, I understand they will then decide whether or not the stations will be erected for account of the State, whether private enterprise shall be licensed to erect them for their own account, or, as a possible third alternative, whether they shall be erected by private enterprise conjointly with the State with State control. I have already on a previous occasion informed shareholders that we had applied to the Imperial Communications Committee for licences to erect and work these stations. We have also intimated our willingness to enter into an alternative arrangement under which we would erect them conjointly with the State, leaving to the State effective control.

These proposals have been under consideration, and the appointment of a Committee by the Secretary of State for the Colonies as Chairman of the Imperial Communications Committee, to advise what stations are required, is, I hope, a step towards securing to the Empire a chain of wireless stations of the latest and best system, comprising all the recent important improvements in wireless communication. Such a network of wireless stations, connecting up the distant parts of the Empire, and so arranged as to communicate with all the other parts of the world, which we can facilitate either through our own stations or through those with which we have priority of service, will furnish a much-felt need in all industrial centres and materially strengthen our hands in the world's competition for trade.

I would also remind shareholders that this company alone possesses for the British Empire all the efficient commercial wireless systems, besides having the sole right of all new patents and improvements, so far as the Empire is concerned, in those systems, even when they originate from any of the important wire-

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less companies in foreign countries, and also the benefit of any and every patent which may emanate from the General Electric Company of America, in so far as it may relate to wireless telegraphy or telephony. The chairman concluded by moving the resolution.

Mr. M. A. BRAMSTON seconded the motion.

FACILITIES FOR STUDENTS.

The CHAIRMAN, in reply to shareholders' questions, said he had seen a notice in the Press intimating to wireless students that, the war now being over, licences to wireless students would be freely given by the Post Office, both for the transmission and the reception of messages. It would be understood, of course, that that was purely experimental work. He understood, further, that certain restrictions would necessarily be imposed in respect of transmission work, and thought that the Post Office would have to be satisfied as to the nature of the transmission work that any student was desirous of doing. So far as he understood the matter, the whole object of the facilities granted by the Post Office was to give the students the opportunities they required to develop their knowledge, understanding, and learning of wireless telegraphy, which he conceived to be an extremely desirable thing from every point of view. That condition of things had existed prior to the war—but during the war, of course, this had to be stopped, and no experimental work at all was allowed by students—but now that the war was over there was every reason why it should be encouraged. He had not seen an announcement to the effect that the Post Office had invited students to use the Government installations for the purpose of acquiring knowledge of wireless telegraphy free of expenses. He had seen every announcement which had been made, and he felt quite certain that such an announcement had not been made, as it would be a practical impossibility for the Post Office to place their installations at the disposal of the students, as their stations had other work to do.

Referring to the relations which existed between the Post Office and the company, he said that shareholders were aware that unfortunately they had been obliged to bring actions against the Post Office by Petition of Right, but those actions had been brought as a result of their being unable to agree with the views of the Post Office as to what should be paid to the company. It was to be hoped, and he for one certainly believed, that the fact they had not been able to settle such questions as those upon which they had had to go into Court with the Post Office would not in any way influence the Government as to what should be given to the country, in the great need of the country, in respect of wireless telegraph stations. He refused to believe that the Marconi Company or the country was going to suffer because there had been a dispute with regard to the settlement of accounts as between a Government Department and the company.

So far as the company was concerned, he had told them on previous occasions that there would have been no Petition of Right and there would have been no disagreement at all, if there had been an opportunity given to the company, even at a sacrifice, to come to an amicable settlement. He did not think it would be possible to erect such stations as were required for an efficient service—a commercial service between this country and the Dominions beyond the sea—without having recourse to the very valuable patents of the Marconi Company, to the great discoveries they had made in recent times, and to the very efficient system they were able to-day to offer. The only possible means of working stations without the Marconi Company would be by adopting an obsolete system, very imperfect, and wholly insufficient for the conduct of a commercial service, and he for one refused to believe that the Government would ever attempt to do anything of the kind, or that it would ever be recommended to them that they should do anything of the kind, or that the country would ever tolerate anything of the kind. He had no anxiety from that point of view.

THE NEW ISSUE OF CAPITAL.

With regard to the proposed issue of shares, he would tell them that the issue would be made somewhere about December 8 or 10. He could not, unfortunately, on that occasion tell them at what price the shares would be issued, nor could he tell them in what proportion they would be issued. Some shareholders had supposed, and he could quite understand their supposing, that the board had already made up their minds, and, as a matter of fact, they had very nearly done so. Nevertheless, they were not able on that occasion to say positively what they were going to do. He hoped it would be possible for the directors to make an announcement within the next day or so, and he could assure the shareholders that as soon as they were in a position to do so they would immediately issue a circular to the shareholders informing them exactly of what they proposed to do, and the issue of shares would be made a few days afterwards. He thought it would be better for the directors to make no announcement until they had quite made up their minds, because, even yet, it was just possible that there might be some change from what they were thinking of doing at the moment, and it would be very undesirable to commit themselves to any statement at that meeting, and still more undesirable to mislead the shareholders.

He had hoped that he would have been in a position to make an announcement on that occasion with regard to the terms of the issue, and possibly if the meeting had been held at

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6 o'clock in the evening instead of at 12 noon, he would have been able to make a definite statement on that matter. He could assure them, however, that the shareholders could be quite satisfied that they would receive the most advantageous terms possible, and that the first and only thought of the board was for the shareholders and for the welfare of the company.

Replying to a further question, he said that he could not inform the meeting as to the amount of the claims made by the company against the Government for services during the period of the war. They asked for *Quantum meruit*. They did not put a figure upon the claim, but in their view they had never received an offer which they thought they were reasonably entitled to expect. With regard to other claims, he had explained at a previous meeting that they were dependent very largely upon one question which was to be arbitrated upon—a claim for services rendered—and they had had to wait until Lord Moulton had fixed a date for that arbitration. The date had now been fixed, but until that matter was disposed of it was not easy to deal with other questions of claims, because they were largely dependent upon the award of that arbitration.

The resolution was unanimously approved, and the meeting terminated.

CIRCULAR TO SHAREHOLDERS.

The following circular to shareholders has been issued by the Directors of Marconi's Wireless Telegraph Company, Ltd. :—

Marconi House,
Strand, London, W.C.2,
3rd December, 1919.

Dear Sir (or Madam),

On the 13th ultimo at an Extraordinary General Meeting of the Company a Resolution was passed authorising the increase of the Company's capital by £1,500,000. The "Times" report of the proceedings of this meeting was duly forwarded to you.

On the 28th ultimo the Confirmatory Meeting was held and a copy of the "Times" report of the proceedings of that meeting is enclosed herewith.

At these meetings the Chairman informed you of the important and extensive developments of the Company's business and the necessity for the substantial increase of the Company's capital in order to provide for the commitments already entered into and to be ready to carry out the offer, if and when called upon to do so, which the Company has made to the Government to construct and organise a thorough and efficient Wireless Telegraph service between all distant parts of the Empire and the Mother Country.

In these circumstances and for the reason which has already been given at the Extraordinary General Meeting on the 13th November, it was regarded as inexpedient to distribute a cash bonus to the Shareholders, but a promise was made this should be compensated for by the terms of the issue of the new capital.

The Directors have pleasure in informing you that in fulfilment of this promise they have decided to issue the whole of the increased capital to shareholders only at £2 per share premium. This will entitle every shareholder, whether he holds Preference or Ordinary shares, to secure one new share at the price of £3 for every share he may hold on the 4th December, 1919, when the register will be closed.

Letters of allotment and renunciation will be posted to both classes of shareholders and due provision will be made for the holders of Share Warrants upon fulfilment of the necessary formalities. The new shares will rank for dividends declared in respect of the period commencing 1st January, 1920, but in all other respects will rank *pari passu* with the existing 1,250,000 Ordinary shares of £1 each.

The transfer books will be closed from Thursday, 4th December, to Tuesday, 9th December, inclusive, for the preparation of allotment letters, which will be posted to the shareholders on or about the 8th instant.

It will be remembered that the Profit and Loss Account for the year ending 31st December, 1918, showed a net profit of £597,938 9s. 0d., which, together with the amount brought forward, left the sum of £974,698 14s. 8d. to the credit of Profit and Loss Account. After payment of dividends amounting to 25 per cent. for the year on the Ordinary shares and 22 per cent. upon the Preference shares and transferring £150,000 to General Reserve Account (making a total to the credit of General Reserve of £1,250,000), a balance of £403,786 14s. 8d. was carried forward to the current year's account.

With the considerable additional capital which this issue will provide, and having regard to the immense development of Wireless Telegraphic and Telephonic business throughout the world, the earning powers of the Company should be greatly enhanced. The Directors are confident that the profits of the current year will justify them in maintaining the rate of dividend, and there is every reason to hope that the increase in the capital of the Company should at least produce a proportionate increase of profits in future years.

I am, yours faithfully,
H. W. CORBY, Secretary.

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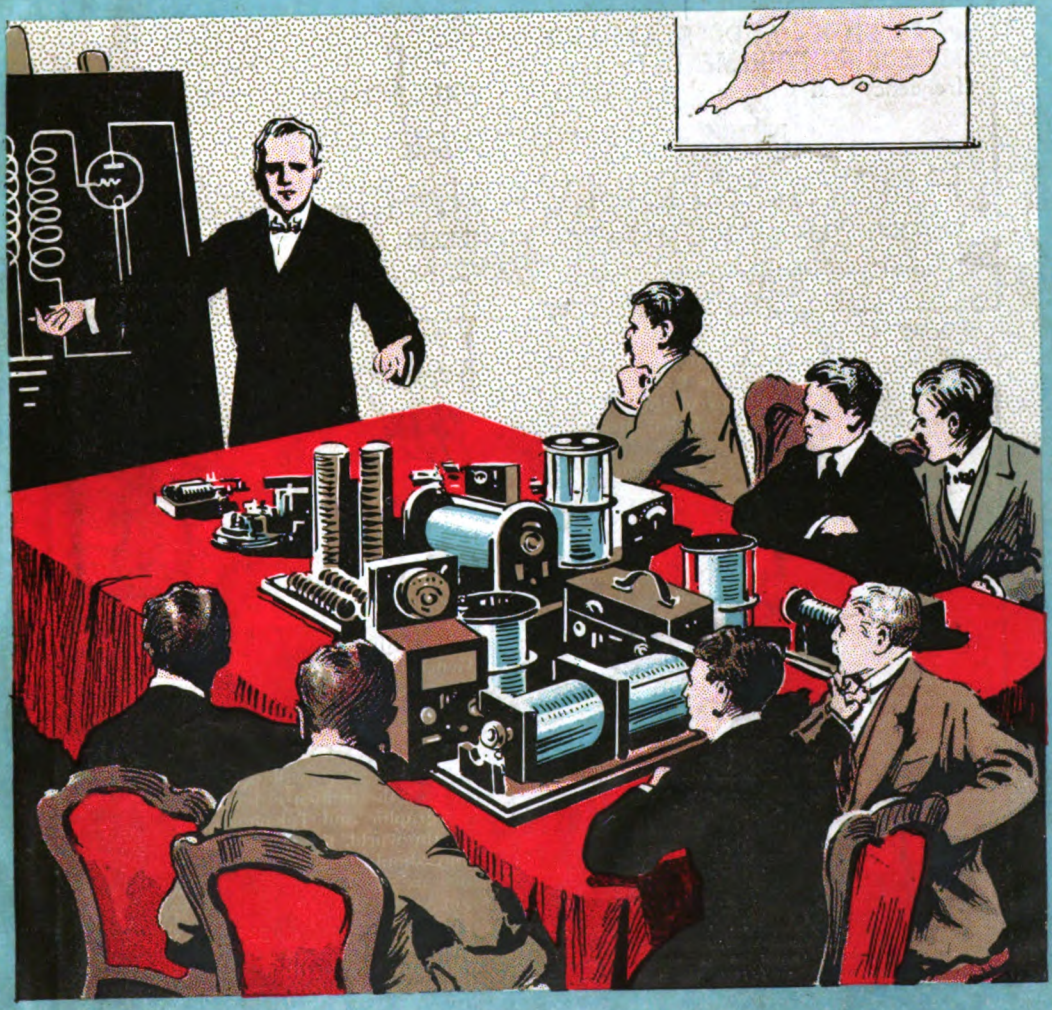
The WIRELESS WORLD



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THE
WIRELESS WORLD

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Vol. VII

FEBRUARY,
1920

The Training of a R.A.F. Wireless Operator.

By Michael B. Egan.

ALTHOUGH most of us might agree that the narrow limits of our native tongue render it unsuited to the task of expressing our private opinions about war in general and the Great War in particular, few of us will deny that four years of Zepp raids and ration cards made us the recipients of a liberal education in our own shortcomings, both as an Empire and as individuals. It might truly be said that each day of the war brought its own particular lesson, but, as often as not, the supreme exigencies of the moment prevented the immediate application of newly-revealed methods owing to the impracticability of upsetting existing organisations, or the necessity for compromising between output and efficiency—between quantity and quality.

The signing of the Armistice, however, gave the signal for the embodiment of those principles and ideas which the war so clearly emphasized as vital to our national success in the great work of reconstruction, and in this respect the post-bellum syllabus for the training of wireless personnel in the Royal Air Force indicates a commendable determination on the part of our youngest service to avail itself fully of the knowledge acquired under the tutorship of war.

Everyone is aware that no other individual branch of science played so important a part in the conduct of the war as the ever-expanding science of wireless telegraphy and telephony. It was wireless that rendered it possible for our generals in the field to discuss strategy with the War Staff at Whitehall whilst preliminary operations were actually in progress. It was wireless that enabled our Admiralty Staff to pin-point the exact position of every British ship on the ocean charts of the world at any moment of the day or night; and it was wireless that enabled our wonder-

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Flowerdown Wireless Training Camp, Winchester.

ful Aerial Squadrons to flash back swift tidings of their progress as they hummed their lonely way above the clouds on their perilous midnight excursions over enemy territory. Wireless was a subtle sixth sense that negatived space and established human intercourse between the Mother Country and the smallest and most remote and isolated contingent of British forces in foreign climes.

The Wireless Operator was ubiquitous.

From the outset of the war the demand for trained wireless personnel was always in excess of the possibilities of supply. Wireless operators could not be made in a day, nor yet in a month, nor, indeed, could they be *made to order* in any length of time.

There is something peculiarly distinctive about the personality of a *real* wireless operator that raises him considerably above the ordinary level and relegates him to a class by himself. Good brains and a capacity for steady application represent two very important characteristics in the composition of an efficient wireless operator, but, although these are two essential factors, they do not in themselves constitute the *ideal* wireless operator. The mentality of the ideal wireless operator must include a natural and instinctive alertness of mind balanced by a capacity for the exercise of sustained self-control during periods of unwonted activity in the world of ether waves.

This pronounced individuality of the *pukka* wireless personality gained daily confirmation during the progress of the war, and by instituting a method of selection which was based on the accumulated data of war-time experiences, the Royal Air Force has aimed at securing the cream of that veritable army of young wireless enthusiasts whose ambition urges them to share the limitless regions of the blue with the happy feathered things of nature.

Enlistment in the Wireless ranks of the R.A.F. is in active progress at the moment. Trained wireless operators and mechanics are being engaged for immediate service and a large number of vacancies exists for boys of about 16 years of age who will undergo a three years' course in wireless telegraphy and

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telephony before being graded as Leading Aircraftsmen in the capacity of wireless Mechanic-Operators. Successful candidature for these vacancies involves a good standard of health, a willingness to engage for 8 years' active service and four years on the Reserve, and a certificate of nomination from the local Educational Authorities. This Educational body will hold periodical examinations at the chief centres, and successful candidates will be granted a nomination certificate for the R.A.F. The examination is not a difficult one; it comprises a number of elementary questions in mathematics and science which are calculated to test the candidate's general intelligence and estimate his suitability for the work to which he proposes to devote his future.

Photo by Bassano

Wing Commander J. B. Bowen, O.B.E., Commandant of Flowerdown Wireless Training Camp, Winchester.

The successful candidate, after satisfying the Medical Officer with regard to his physical fitness will then proceed to the Air Force Training Camp at Halton Park in the rank of Boy Mechanic. Here the first six months of his training will be devoted to general workshop practice, physical training, sport, and general education. It will also include the inculcation of that very important and beneficial thing which is the foster-mother of *esprit de corps* and healthy comradeship in every service—the true spirit of discipline.

On the completion of this preliminary stage the future airman will embark upon two and a half years of specialised training at the Wireless Training School at Flowerdown Camp, Winchester. The Flowerdown Wireless course is divided into five different stages, each of which lasts a little over five months, the balance of the time being absorbed by liberal holidays during the summer and at Christmas. At the end of Stage I a terminal examination is held and a survey of the results enables the Chief Instructor to classify all students as (a) satisfactory and ready for further training, (b) in need of a repetition course, (c) unsuited for further training in this sphere of work.

In addition to these terminal examinations, which are held at the close of each stage, all Boy Mechanics are obliged to enter for the City and Guilds Elementary and Ordinary Examinations at the termination of Stages I and II respectively, and, at the end of the whole course—when the successful Boy Mechanic is *immediately* promoted to the distinctive rank of Leading Aircraftsman—examinations are held for the City and Guilds Advanced Certificate and also the Post-Master-General's certificate for Sea *and* Air.

This is certainly an excellent scheme

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which cannot be praised too highly. Its inauguration marks the rapid destruction of that almost insuperable barrier which in the past too frequently separated the " time served " soldier or sailor from his rightful place in the commercial world. Truly it was a valuable war lesson which can claim responsibility for the fact that the time-served airman of the future will step back into civil life with *certificated* qualifications *at least* as good as those possessed by the men amongst whom he is going to compete in the nation's industry!

As it is outside the scope of this article to enter into a detailed account of the complete Wireless course, a brief consideration of the manner in which the subject matter of Stage I is treated must suffice to indicate the very high standard of efficiency which characterizes the whole programme. Stage I is arranged in a very delightful and ideal manner. The technical training commences with a series of introductory lectures which are delivered each day on such subjects as " The Physical Properties of Ether," " The Constitution of Matter," " What are Molecules, Atoms and Electrons," etc., etc. In conjunction with these lectures simple experiments are chosen and demonstrated with a view to emphasizing the fundamental ideas set forth in the lectures. For example, in the early part of the course, detailed experiments are arranged whereby the students can with *their own* senses *observe* the various phenomena associated with positive and negative charges, static and current electricity, magnetic and electric fields, the relationship between the pressure, current, and resistance in a simple electric circuit, etc. All these fundamental phenomena are demonstrated during the preliminary lectures and each pupil is afforded ample opportunity for repeated investigation under his own management. In this way, in the light of his own individual discoveries, the student is encouraged *to deduce from personal observation*, the most important elementary principles —such as are embodied in Faraday's, Lenz's, and Ohm's laws.

Great and justifiable attention is given to this aspect of the preliminary training. There is no attempt to cram or to insist on the memorisation of cumbersome formulæ by rule of thumb. From the outset, no effort is spared which is likely to assist the development of that attitude of interested curiosity than which no other attribute is so essential to the mental equipment of the student of science. As the course continues, the future wireless operator is introduced to those electrical properties associated with the terms " Capacity," and " Inductance," and exhaustive experiments are conducted with a view to establishing an accurate and indelible conception of these important principles.

After this the student is familiarised with simple electrical measurements and the next portion of Stage I deals with the commoner types of secondary batteries, their installation, and the necessary precautions for their charging and discharging, etc. Simple circuits in connection with electric lighting are then dealt with and the concluding lectures are devoted to the less complex types of continuous current dynamos and motors.

The whole course is hall-marked by a sound appreciation of the necessity of combining theory with practice. Each day's programme includes the allocation of a suitable period for practical work in the Instrument Laboratory and the Electrical Workshops. In the Instrument Laboratory are carried out those

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A lecture in progress.

elementary electrical experiments to which reference has already been made. In addition, the incipient wireless operator is here instructed in the use of various instruments employed in connection with electrolysis, general galvanometry, and calibration, special attention being given to the measurement of resistances by the Wheatstone Bridge, The Post Office Box, Meggers, etc. Here also dynamos and motors are subjected to practical tests from the results of which students are enabled to evolve and compare the "efficiency curves" of individual machines.

In the Electrical Workshops is to be found a variety of lathes and tools, and well-stocked benches such as only exist elsewhere in the wildest dreams of the ambitious wireless amateur. Here the young enthusiast is taught to attack a real practical job of work. Under the heading "Fitting and Turning," the practical work of Stage I includes instruction in the use of ordinary workshop tools, bench-work, forge-work, the use of treadle and power lathes, drilling and boring, screw-cutting, etc., and due attention is also given to the necessity for clear and systematic diagrams and the cultivation of an ability to work direct therefrom.

In addition to the technical instruction, an appropriate period is set aside in each day's programme for (a) General Education, (b) Buzzer and Visual Signalling, and (c) Physical Training and Drill. The syllabus for general education includes Practical Mathematics, English, Mechanical and Practical Drawing, Elementary Physics and Mechanics. In the Signal School, where Morse buzzer practice is in constant progress, the embryonic airman is also trained as an efficient exponent of the various methods of visual signalling which are employed by his brothers-in-arms, the soldier and sailor.

After an interval of five weeks Stage II begins, and this is really an advanced continuation and amplification of Stage I. Stage II is also succeeded by a test examination from which the industrious and successful worker emerges with the key that opens the door to further scientific training. Another important process of selection is applied at this period. All satisfactory students are now re-classified and

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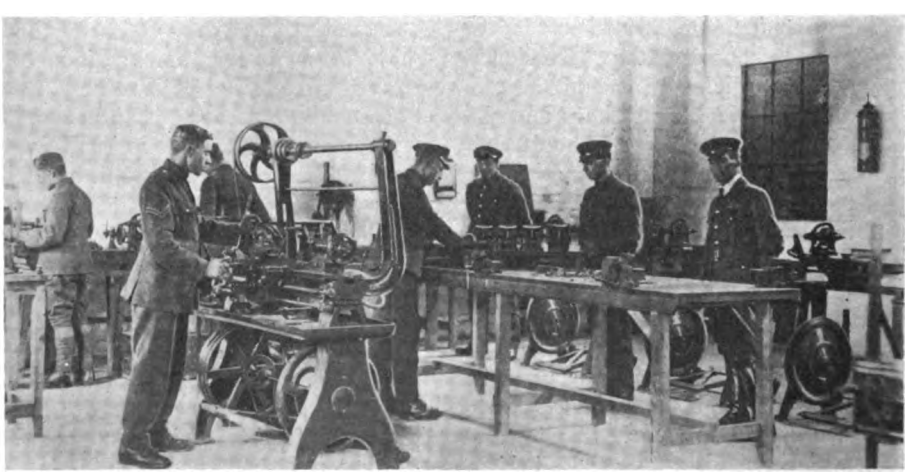
each one is " labelled " as having shown an individual aptitude for such particular portions of his previous work as indicate his suitability for specialized training as (a) an Electrician, (b) a Mechanic-Operator.

The remaining three stages are now devoted exclusively to either of these two branches of study. Those who pursue the career of an Electrician will conclude their course with the City and Guilds Advanced Examination, and Mechanic-Operators will sit for the P.M.G.'s Certificate for Sea and Air. One of the most important developments in the economics of wireless is expressed in the term Mechanic-Operator. During the war we trained great numbers of mechanics and great numbers of operators and thus practised a system of wasteful duplication that was only justified by the abnormal conditions and necessities of the moment. The straining demands of the war have now ceased however, and their withdrawal has rung up the curtain on a new and more economical organisation. The R.A.F. Mechanic-Operator of the future will be, as his name suggests, an efficient " self-contained " unit. In the many strange circumstances and climates through which his adventurous career must inevitably lead him, the nature and quality of his specialized training will always signalize him as an important and independent link in the chain of aeronautical development.

Capt. H. Leedham, Chief of the Staff of Wireless Instructors at Flowerdown Camp.

The last three stages of the Mechanic-Operators' Course are devoted to all types of Aerial Wireless Telegraphy Instruments (spark and continuous wave), Corps Squadron Work, Wireless Telephony, and Wireless Direction Finding. They also include a lengthy programme of Aerodrome Practice which assures that every qualified Mechanic-Operator will have had considerable practical experience of working



A Corner of one of the Workshops.

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under difficult conditions during flight. Having successfully completed his course the now full-fledged Leading Aircraftsman is available for dispersal to any of the various fields of wireless activity associated with the work of the Royal Air Force.

His first "job" may drop him neatly into the wireless cockpit of an aeroplane or seaplane, or the more luxurious surroundings of the Wireless Cabin on a giant airship. On the other hand he may kick off with a warmer billet in an Aerodrome W/T Station, a Direction Finding Station, or a motor launch used in co-operation with seaplane work. Whatever be the conditions under which he makes his *début* in the world of aeronautical wireless he will find himself standing beneath one of the many signposts that point the way to an industrious and successful career in the R.A.F.

It would not be fair to the originators and executors of this comprehensive syllabus to omit reference to the important and intelligent schemes which are in operation in connection with the provision of suitable opportunities for physical and intellectual recreation during leisure hours. Every form of outdoor sport is encouraged. Cricket and football, inter-School teams and leagues are in full swing at all times, and long lists of fixtures are arranged with outside schools and clubs and other branches of the service. A well stocked gymnasium will provide the means for passing many enjoyable and profitable hours. For those who feel themselves unduly burdened with a multitude of new and original ideas (and who does not pass through this stage at some period or other?) a debating society affords ideal opportunity for conducting misguided fellow students into the shining realms of truth. An enterprising dramatic society is ever on the look-out for fresh histrionic talent, and a well filled library strives to cater for the most fastidious literary tastes and provides a haven of peaceful solitude for the thoughtful soul.

To crown all, if one is addicted to the musical vice, no time need be lost in making arrangements to contribute one's just share to the unearthly din which is responsible for the desolate and uninhabited aspect of the Camp on Band Practice evenings!

Operators in the Station at the Air Ministry.

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DOCTOR CORNELIS JOHANNES DE GROOT.

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Personalities in the Wireless World

DOCTOR ENGINEER CORNELIS JOHANNES DE GROOT was born at den Helder on the 27th of January, 1883, graduated at the Technical High School at Delft as Mechanical Engineer, and afterwards obtained the diploma of Electrical Engineer at Karlsruhe.

After spending eighteen months in the service of the General Electric Co. at Berlin he passed over to the Dutch East Indian Government and superintended the erection of various wireless telegraph stations in the Indian Archipelago.

During his furlough in Europe in 1915-1916 he took his degree as Doctor in Technical Science at the Delft University on the dissertation "Radio-Telegraphy in the Tropics," which work was afterwards published. The Doctorate was conferred upon him "cum laude" after his defence of the thesis :—"A Radio-Telegraphic Communication between Holland and its Colonies without the use of relay stations is politically a necessity and technically possible."

Immediately upon his return to the Indies in 1916 he set to work to prove the practical feasibility of his scheme. Being promoted to Chief of the Radio-Telegraphic Service in the Indies, he took up quarters at Bandoeng, and after many trials with an installation partly of his own construction and by means of his receiver placed purposely on board of H.M.S. de Zeven Provincien, he succeeded in keeping radio-telegraphically in touch with this war vessel all over the Pacific Ocean up to Panama, which was a record in wireless transmission from shore to ship.

This special receiver was installed later on at the experimental station near Blaricum in Holland, and took the first wireless message ever received in Holland direct from Bandoeng. For this feat he was lionized and fêted by the citizens of Bandoeng.

As soon as the transmitting station now being built in Holland is completed, a direct Radio-Telegraphic Service between Holland and its Colonies will be established.

One of Dr. de Groot's best known works is his paper entitled "The Nature and Elimination of Strays," which was read before the Institute of Radio Engineers, New York.

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An Efficient Variable Condenser

By G. W. Hale.

NOW that the restrictions on Private Wireless are somewhat relaxed and wireless enthusiasts all over the country are contemplating the construction of their apparatus, a description of an easily constructed variable condenser which possesses several advantages over the ordinary semi-circular vane type will no doubt be appreciated.

The component parts of the condenser are shown in the accompanying sketches.

The rotor, Fig. 1, consists of a disc of ebonite or similar insulating material, the under surface of which should be as flat as possible. The two semi-circular tin—or preferably copper—foil plates B and C are attached to the under surface of the rotor by means of shellac varnish, which should first be allowed to harden, the plates being held in position and then pressed with a hot flat-iron. This method precludes the possibility of moisture causing defective insulation. Contact is made to the right-hand plate C by means of a round nut on the spindle as shown, while the left-hand plate B is connected through the lug D to a brass or copper strip which is bent around the circumference of the rotor as shown, and screwed at each end with 6 BA countersunk brass screws. The Stop Pin E is a piece of brass wire screwed into the side of the rotor, and by working between the stops E_1 and E_2 on the base (see Fig. 2), prevents the rotor from being turned through more than 180°. The fixed conductors F and G (Fig. 2) are attached in a similar manner to those of the rotor and are connected to their respective terminals. The pillar at the back of the base supports a brush of springy brass which should be set to bear evenly on the contact strip on the rotor. The brush should be cut in two or three places so as to give the smallest possible contact resistance. The wire J from the left-hand terminal, as shown by the dotted line, is soldered to a brass washer K, and thus makes a connection to the rotor spindle. Between the upper and lower plates is placed a disc of thin sheet-ebonite $\frac{1}{8}$th or $\frac{1}{100}$th of an inch in thickness. Photographic celluloid film may also be used. The gelatine must be removed from both sides of the film, which may easily be done by soaking it in warm water for about five minutes, and scraping with a blunt knife. The rotor spindle is placed through a recessed hole in the base and secured underneath with a couple of nuts bearing on a spring washer and the washer K. The spring washer should be compressed just sufficiently to permit easy movement of the rotor. The adjusting

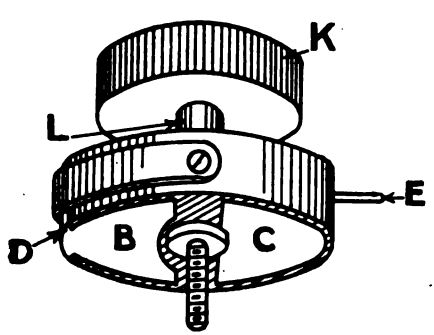

Fig 1.

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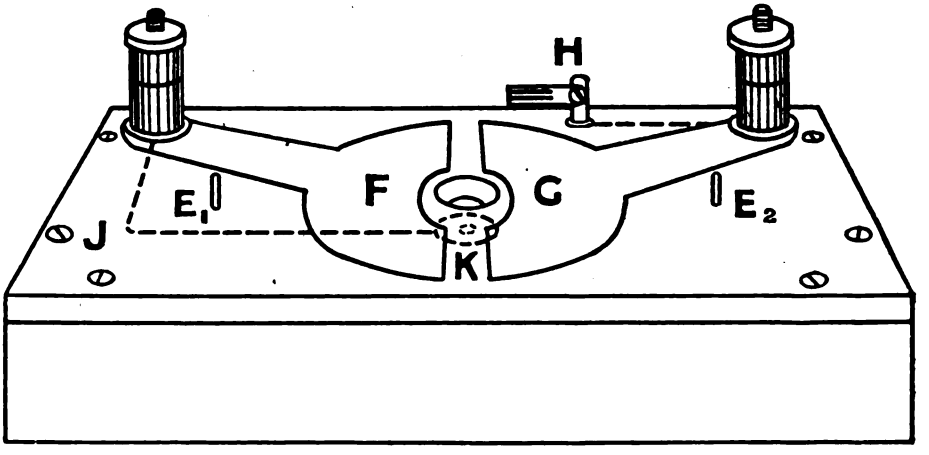

Fig. 2.

knob and distance piece are drilled and tapped (2BA) and screwed on the spindle which should not project above the upper surface of the knob. The completed instrument is depicted in Fig. 3.

For tuning a short wave receiver secondary the condenser described is just right as its minimum capacity is practically zero, a feature which is not frequently met with in the ordinary multi-vane type of condenser where the edge-to-edge capacity of the two sets of zinc plates is quite considerable, making it often necessary to disconnect it from the circuit altogether. This results in a sudden reduction of wavelength, requiring a readjustment of inductance. When using a valve receiver

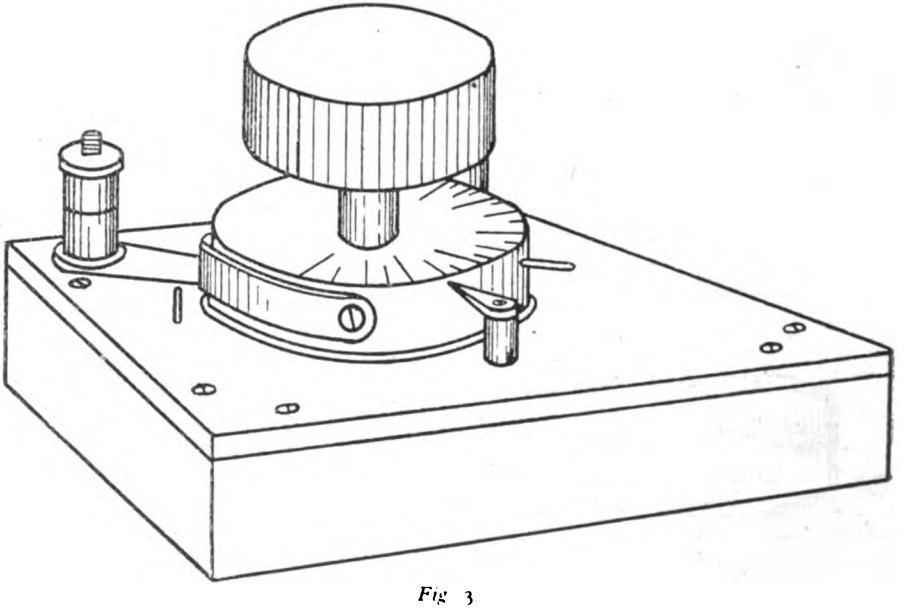

Fig 3

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it is usually preferable to tune the circuits with as little additional capacity as possible, relying on the inductance of the coils in conjunction with their own capacities and that of the connecting leads to give the desired wavelength. As a guide to those readers who may wish to construct a condenser of this type the following dimensions may be of use (see Fig. 4).

Rotor (ebonite), diam. $2\frac{1}{4}$ inches, thickness $\frac{1}{2}$ inch.

Adjusting Knob (ebonite), diam. $1\frac{3}{4}$ inches, thickness, $\frac{1}{2}$ inch.

Distance Piece (ebonite), length $\frac{5}{8}$ inch diam. $\frac{3}{8}$ inch.

Celluloid or Ebonite Disc, diam. $2\frac{3}{8}$ inches, Centre Hole, $\frac{3}{8}$ inch.

Spindle, 2BA Screwed Brass Wire $2\frac{1}{4}$ inches long.

The base may be made from $\frac{1}{4}$ inch sheet ebonite and should be about 4 inches long and $3\frac{1}{2}$ inches wide. If desired it could be made part of the panel of a complete cabinet receiver, according to the individual needs of the experimenter.

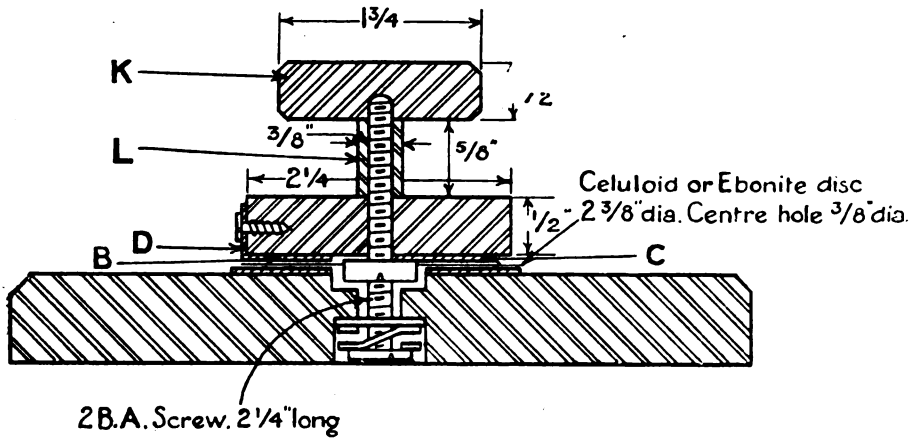

Fig. 4.

A Condenser made as described was found on test to have a maximum capacity of 0·00017 mfd. using $\frac{1}{64}$th inch thick ebonite dielectric. The capacity if celluloid film is used is somewhat higher as it is only about a fourth the thickness.

A FLEXIBLE SOCKET FOR WIRELESS RECEIVING VALVES.

By E. W. Kitchin, A.M.I.C.E.

THE usual rigid socket for a three-electrode valve has the disadvantage of being unable to adapt itself to slight manufacturing variations in the "set" of the plugs which form the electrode terminals. One or more of the plugs may be slightly out of the straight, involving the risk of strain if the valve is forced into a perfectly rigid socket. The following method of constructing sockets, recently devised and used with great success by the writer, produces a valve socket with sufficient flexibility to enable a valve to be inserted easily and

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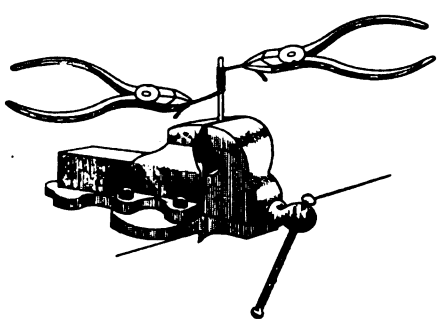
make good contact without risk of straining the plugs. It has the further advantages of cheapness and ease of construction, which will recommend it specially to the amateur.

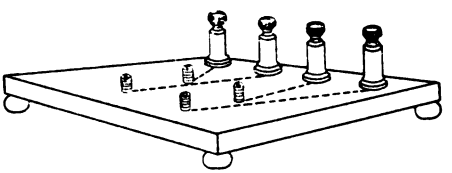
Procure some brass or copper wire of No. 18 S.W.G., the correct gauge being important. Clean the wire well, and if of brass, soften it. Fix a "former" made of a short length of No. 10 S.W.G. wire in a vice, and wind the wire round it closely for nine or ten turns. Adjacent turns should touch, and the coil will be about half an inch in length. Care must be taken to wind the wire in such a direction that the coil forms, as it were, a right-handed screw thread. Tighten the coil on the former by using two pairs of pliers in opposition, and make the end of the wire quite smooth. Leave on the other end a few inches of straight wire, and finally slide the coil bodily off the "former." One of these coils will be required for every plug of the valve.



Having prepared a piece of sheet ebonite of convenient size, and preferably not less than $\frac{1}{4}$ inch thick, press the plugs of a valve on a piece of paper with sufficient force to leave a mark from each. Transfer this template to the ebonite and mark through the paper, with a sharp point, the positions of the centres. Drill holes at these points, and tap each with $\frac{1}{4}$ inch Whitworth thread.

Now carefully screw one of the wire coils into each hole, starting from the under side of the ebonite, until each coil projects about $\frac{1}{4}$ inch above the ebonite; the bottom end with the piece of straight wire will then be about flush with the under side.

Fix four terminals in convenient positions on the ebonite, and connect each of the straight ends of wire to one of these, cutting off any surplus.



Attach four small feet to the under side of the ebonite base so that the wires and terminal bottoms will not touch anything when in use, and the apparatus is complete.

If thicker ebonite than $\frac{1}{4}$ inch is used the coils should be proportionately longer, the idea being to have them flush with the under side and projecting $\frac{1}{4}$ inch above.

If carefully made, the coils will fit tightly in the holes, but it is perhaps as well to spread them from the under side by forcing a tapering instrument in, and giving it a few twists. This will press the lower turns of the coil well home into the screw thread cut in the ebonite.

The split plugs of the valve should be carefully opened out somewhat if necessary.

The sockets may, if desired, be made still more flexible by making the coils longer and increasing the portion which projects above the ebonite base. This is, however, not recommended in view of the possibility of two adjacent coils being accidentally caused to touch each other.

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Stray Waves

THE AMATEUR POSITION.

ON the surface the situation has undergone no change since we last went to press; the Government has made no further move and there is no news of the promised Wireless Telegraphy Bill. Yet the amateurs themselves are steadily altering the state of affairs, witness the persistent increase in the membership of the existing clubs, the rapid recrudescence of clubs whose activities ceased when the war broke out, and the numerous new clubs which spring into being every month.

We are glad to note that several clubs have decided to affiliate with the Wireless Society of London. Such a course, we feel sure, will benefit the whole amateur community without robbing the individual clubs of their freedom to work along their own lines.

We are still under the impression that there are a number of clubs existing with whom we are not yet in touch. Will their Secretaries be good enough to communicate with us, thus aiding us to complete our list. We constantly receive enquiries for details of the clubs nearest to certain towns.

* * *

POWER FROM THE SUN.

Commenting on Sir Oliver Lodge's recent Truman Wood lecture at the Royal Society of Arts, Mr. A. A. Campbell Swinton, in a letter to *Nature* (Dec. 18, 1919), points out that in referring to the probable high efficiency of vegetation as a utilizer of solar energy, the lecturer appeared to be unaware of the fact that Dr. Horace Brown has shown that the actual amount of energy stored is less than 2 per cent of that reaching the vegetation. This amount is, during daylight, more than 1,000 H.P. per acre. The main object of Mr. Campbell Swinton's letter is to suggest that there is probably a better way of utilizing solar energy than by converting the radiation first into heat and he asks whether it is not worth while to consider the possibility of employing some method involving an action analogous to that of the thermionic valve, in order to produce electric currents without an intermediate step.

* * *

RADIOGONIOMETER AND TRIANGULAR DIRECTIVE AERIAL PATENTS.

We are requested by Mr. E. Bellini to give publicity to the following, in view of the item which we published under this heading in our Dec. (1919) issue:

"In the Numbers of October 24 and 31, November 7, 14, 21, &c., of *The Electrician*, page xxx of the announcements under the heading 'Patent Rights for Sale, &c.,' Mr. Artom published under the above title a short and confused note, from which readers could believe that the Italian Courts had judged that the Radiogoniometer, the Direction Finder and the Triangular Directive Aerial were invented by Mr. Artom.

"This affirmation is incorect. In 1915 and 1917 in this same Journal Mr. Artom had advanced the same pretension, which was the origin of a public correspondence with Mr. Bellini.

"It is necessary to repeat here, in the name of truth and justice, that the

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Italian Courts not only did not judge this question, but, on the contrary, they explicitly declared that they had not to decide it. The translation of the part of the judgment containing the said limitation is as follows:—

'It is not decided here whether the inventions, the subject of the Italian Patents, No. 88,765 and No. 88,766, were made by the scientists Brown and Blondel, or by Mr. Artom, or by MM. Bellini and Tosi. . .'"

* * *

WIRELESS POLICY IN AMERICA.

A new policy for the control and development of wireless communications in the United States was placed before Congress by Mr. Secretary Daniels on October 15th. It provides for maintenance of Naval and Private Stations, with the latter under the control of a National Wireless Commission. It deals with the licensing of Private Wireless Stations in the matter of assistance to Americans in establishing wireless facilities with foreign countries. The National Wireless Commission would attend Board Meetings of Private Companies. Aliens or alien interest could not obtain licences from the Commission and all Officers and Directors of Private Wireless Companies would have to be American citizens and the majority of the stock of such companies would have to be held by Americans. Private Wireless Companies would not be permitted to affiliate with Submarine, Cable, or Land Telegraph or Telephony Systems without consent of the National Commission, and would not be permitted to operate in the Philippines or Panama Canal Zone.

THE NEW PATENTS ACT.

For the benefit of those of our readers who have to do with the patenting of inventions or who intend to devote themselves to investigations which may result in discoveries worth patenting, we briefly describe hereunder the alterations in the law which are embodied in the new Act. Firstly, the period between the filing of the provisional and the complete specifications has been increased to nine months,—a very beneficial measure, as will be fully appreciated by all who have taken out patents. Next, the Patent, under the new Act, will be allowed to run for sixteen years, an increase of two years, the advantages of which are obvious.

A number of rules are laid down to provide against abuses of the Patent Law by foreign inventors, who were formerly able to dodge the law to the disadvantage of British patentees. Under special clauses the British inventor is protected much more than formerly. All patents must be worked within four years.

In respect to claims an amendment is enacted whereby the inventor who finds it necessary to prosecute for infringement, need only prove the validity of his principal claims. Under the old law, if he failed to support an unimportant subsidiary claim he lost his action and the infringer reaped the benefit of his malpractice until the inventor amended his specification.

The extensions of the terms of patents has been altered from seven and fourteen years to five and ten years respectively, and the Act has been made retrospective, thus prolonging for two more years patents which otherwise would expire this year.

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Digest of Wireless Literature

THE SELF-OSCILLATIONS OF A THERMIONIC VALVE.

By R. WHIDDINGTON, M.A., D.Sc.

Cambridge University Reporter, May 27th, 1919, also *Radio Review*, November, 1919.

IT has been found possible to produce oscillations of almost any frequency by means of a three-electrode valve without employing the usual capacity-inductance circuits. A soft valve is used which contains sufficient quantities of gas or vapour to permit of collisional ionisation taking place. Fig. 1 shows the circuit normally employed for the production of these oscillations. It will be seen that there are here no capacity-inductance circuits whatever as the resistance R is non-inductve, consisting normally of a soft lead pencil split lengthways and fitted with a small metal sliding contact. With batteries of suitable magnitude strong oscillations may be set up in this circuit the frequency of which is determined almost entirely by the value of the grid potential and the geometry of the valve electrodes. These oscillations can be detected, and their wavelength measured by means of an ordinary heterodyne wavemeter placed near the circuit.

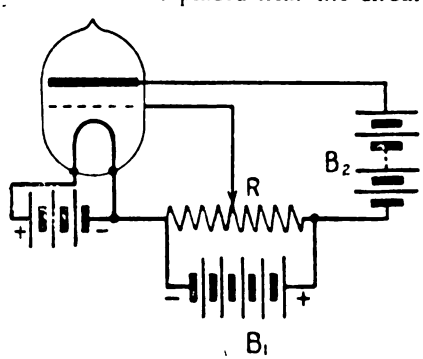

Fig. 1.

To account for these oscillations which, broadly speaking, are to be regarded as being due to periodic surges of mercury ions closing in on the filament, one must assume that although the filament as a whole is emitting electrons continuously according to Richardson's law, yet there are often isolated spots which emit with exceptional power. If this is granted it also seems reasonable to assume that the bombardment of the filament by rapidly moving positive ions in the neighbourhood of such an emitting spot would greatly increase the local emission.

A burst of electrons starting from such a spot on the filament would travel from filament to grid under the influence of the small grid potential normally used. On passing through the grid interstices the electrons travel into the strong electric field of the anode and attain sufficient velocity to produce collisional ionisation among the residual mercury atoms in the tube. The positive mercury ions so formed now travel back to the filament and bombard the original emitting spot, causing another burst of electrons to travel towards the grid and cause the whole process to be repeated in a regular manner. On account of the repetition of this cycle of operations the anode current is of a pulsating nature and thus may be regarded as possessing both a steady and an oscillatory component. On this theory it may be shown that the frequency n of the oscillation set up is given by the formula

$$n^2 = 2 \cdot \frac{e}{m} \cdot \frac{V}{d^2} \quad \ldots\ldots (1)$$

where $\frac{e}{m}$ is the charge to mass ratio of the positive ion concerned, d is the radial distance of filament to grid, and

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V is the positive grid voltage. This method of producing oscillations suggests a wireless method of determining the value of $\frac{e}{m}$ as the other quantities of equation (1) can be measured. It also suggests the possibility of producing extremely short wireless waves by a method entirely different from the ones normally employed.

MESURE EN VALEUR ABSOLUE DES PERIODES DES OSCILLATIONS ELECTRIQUES DE HAUTE FREQUENCE.

By MM. Henri Abraham and Eugène Bloch.

Annales de Physiques, Oct. 1919.

The exact determination of the wavelength of electrical oscillations is the basis of all high frequency measurement. Its importance is particularly evident in the calibration of wavemeters for practical work in radiotelegraphic transmission. However, nowadays things are quite different. The development of Wireless Telegraphy in all directions has caused the multiplication of sending stations. Also the use of continuous waves, introducing the possibility of exceedingly fine tuning, requires that our wavemeters should be much more accurate than they were formerly.

The new method proposed for the calibration of wavemeters consists in determining not the wavelength of the oscillation but the period. This period is determined by making it identical with that of a harmonic of a low frequency valve oscillator, the frequency of which can be made identical with that of a standard tuning fork. For example, if a tuning fork of a frequency of 1000 is used a wavemeter can be tested at a frequency of 150,000 ($\lambda = 2000$ metres approximately) provided the valve oscillator emits harmonics up to the 150th. An ordinary heterodyne wavemeter emits harmonics say up to the 12th but by using a special circuit (known as a "multivibrateur") it has been found possible to obtain harmonics with a frequency 300 times that of the fundamental.

The full set of operations may thus be briefly summarized as follows:—

(a) The frequency of the standard tuning fork is determined exactly by comparison with a standard clock.

(b) The fundamental frequency of the multi-vibrateur is made equal to that of the standard tuning fork.

(c) The wavemeter is now calibrated by comparison with a harmonic of known order. Electrical resonance is utilised for this adjustment. The wavemeter circuit is coupled very loosely both with the multivibrateur circuit and also with a detector-amplifier. A heterodyne circuit is loosely coupled to the latter to enable the adjustment to be made by means of an audible beat note. The arrangement used is shown in Fig. 2.

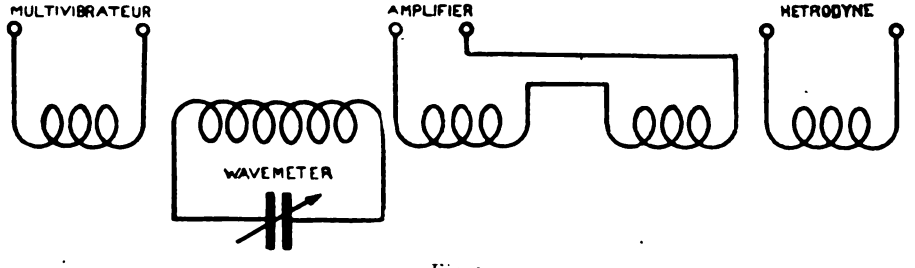

Fig. 2.

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Notes on the Physics of the Thermionic Valve

By T. G. Petersen.

(*Continued from January Number.*)

Alteration of Anode Diameter, or distance from Filament.

It is not proposed to deal at any length with the alteration of anode diameter, since the idea of the stray field and the counter field (or assisting field, as the case may be) will now have been thoroughly grasped, but a passing reference should be made to Fig. 11. It will therein be noted that when the plate is in position P_1, E_s will have a certain value, but when at P_2 this value becomes less, until in position P_3, it becomes zero.

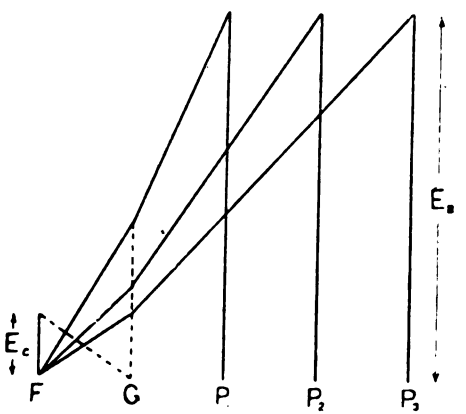

Fig. 11.

Hence, the general statement may be made, that the combined effect of the grid and a negative potential impressed on it tending to diminish the valve current, is increased when the plate is moved away from the grid.

Effect of Space Charge on Slope between G and F.

It will have been noticed that the existence of a space charge between grid and filament has, up to the present, been ignored. When it is remembered that this is a negative charge situated between grid and filament it will be readily understood that it will have some effect upon the slope along this portion of the field E_S. Now the space charge only exists when electrons are emitted from the filament at a faster rate than they can be carried away by attraction of the field E_S. Thus any excess of electrons will set up an electric field counter to E_S. If then we regard the conditions in this manner, it is seen that the result upon the slope of E_S will be analogous to that obtained by decreasing the mesh of the grid or increasing a negative potential on the grid, as already outlined.

A conception of the effect upon the slope between G and F is shewn in Fig. 12, in which the plate has been left out. The height HG represents the value γE_B, but this is reduced, by reason of the counter field of FJ to KG, which is equivalent to $\gamma E_B - E_C$. SC_1, SC_2, and SC_3 represent the loca-

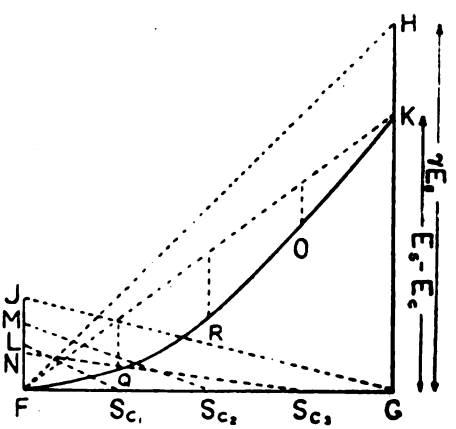

Fig. 12.

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tion of the space charge and FL, FM, and FN are proportional to the intensity at the respective points. Deducting FN brings the slope down to O, similarly deducting FM and FL lowers the corresponding points of the slope to R and Q respectively. The slope therefore becomes curved similar to the line F, Q. R, O, K, which shows clearly how the velocity of electrons leaving the filament may be seriously decreased when the space charge is present.

Operating Constants.

Owing to the vast amount of research work which has been carried out by many prominent wireless and other experts, a number of the constants of the three-electrode valve, which were not long ago more or less unknown quantities, may now be deduced from its structural dimensions and the applied potentials. Therefore in addition to the store of information regarding valves thus provided, their design is greatly facilitated. Amongst the constants which are most important are those contained in the appended list. There are others, but they are hardly within the scope of these elementary notes. We will therefore limit our considerations to the four factors enumerated:

Factor	*Sign*
Plate Current	I
Voltage Amplification Factor	μ
Maximum Voltage Amplification Factor	μ_o
Plate Resistance	R_o

Plate Current.

Various formulæ have been given for the calculation of the plate current I; for instance, Langmuir gave

$$I = a\,(E + KE_g)^{\frac{3}{2}} \quad \ldots\ldots\ldots(1)$$

in which E is the plate voltage, E_g the grid voltage, K the maximum voltage amplification factor, and a is a factor dependent upon the valve dimensions.

Van der Bijl has shown that I can be calculated from the equation:

$$I = a\,(\gamma E_B + E_C + \epsilon)^2 \quad \ldots\ldots\ldots(2)$$

in which a and ϵ are constants depending on the dimensions of the valve (see preceding remarks). E_B and E_C correspond to E and E_g of Langmuir's formula (1) and γ (gamma) is the reciprocal of the maximum voltage amplification factor.

But for practical purposes the plate current can be calculated from Langmuir's original emission current equation, in a revised form, which considers the action of the grid by the inclusion of the function μ_o, thus:

$$I = 14{\cdot}65 \times 10^{-6}\,\frac{l}{r}\left(\frac{E}{\mu_o} + E_g\right)^{\frac{3}{2}} \ldots\ldots(3)$$

That this satisfies the case for practical purposes will be seen by reference to Fig. 13, which shows the plate current—grid volts characteristic of a typical V24 valve, for seven different plate voltages.

Taking the values as follows: l = 2 cms., r = 0·686 cms., E = 35 volts, E_g = 4 volts, and μ_o = 7, we obtain the following result:

$$I = 14{\cdot}65 \times 10^{-6} \times \frac{2}{0{\cdot}686}\left(\frac{35}{7} + 4\right)^{\frac{3}{2}}$$

$$= 1{\cdot}15 \text{ milliampères.}$$

It should be noted, in passing, that

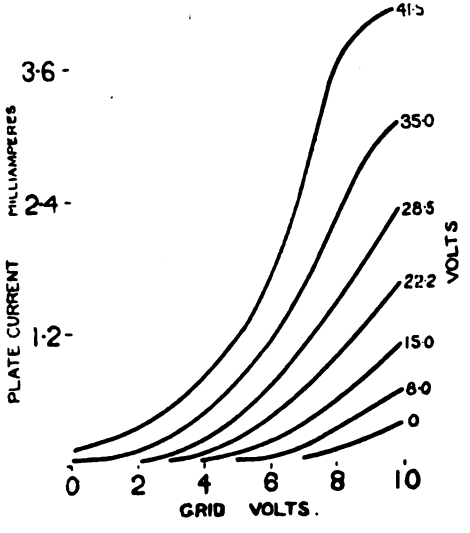

Fig. 13.

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in plotting the values in Fig. 13 a series resistance was used in the negative end of the filament, across which there was a voltage drop of approximately 1·5 volts, so that E_x corresponds to the position 5·5 volts (positive), along the x axis.

The method (3) replaces the constant a in (1) and (2) by $14{\cdot}65 \times 10^{-3} I_r$ and, since the computation of these constants is rather a complicated process, offers a ready means of ascertaining mathematically the approximate value of the plate current obtainable, given certain constants.

It is interesting to note that the value of plate current obtainable in modern transmitting valves exceeds 350 milliampères, even when the grid is maintained at a high negative potential. In Fig. 14 are depicted three curves showing the plate current values, at 4,000, 6,000, and 8,000 volts, of a medium power transmitting valve.

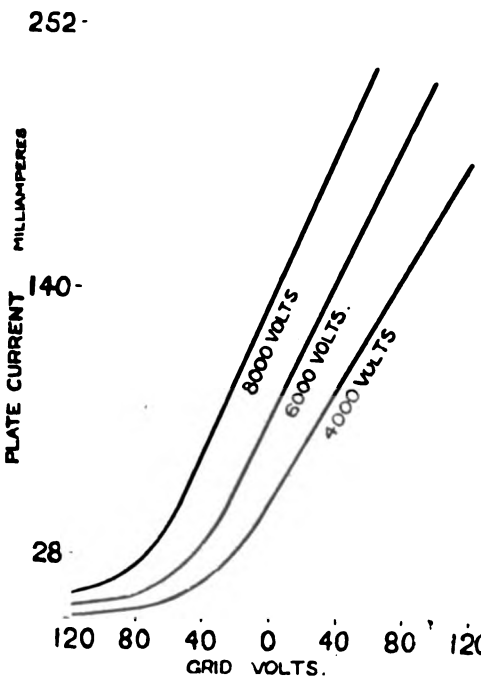

Fig. 14.

Voltage Amplification Factor.

In the case of a valve to be used as an amplifier, one of the chief of its constants is that which denotes its value of magnification. Such factor may be termed its voltage amplification factor, and is expressed as a ratio of change in voltage on the plate, for a constant plate current.

For instance, let us suppose that with the grid of a valve 5 volts positive, and its plate 50 volts positive, a current of 2 milliampères flows in the plate circuit. Let the plate voltage be lowered to 41 volts (*i.e.*, a decrease of 9 volts); then if by increasing the grid voltage to 6·5 volts (*i.e.*, an increase of 1·5 volts) the plate current remains the same, the voltage amplification factor at this point is $\frac{9}{1{\cdot}5} = 6$.

It will thus be seen that μ can be found practically by plotting the characteristic plate current—grid volts curves for various plate voltages, and it is now proposed to show the method of operation. It is not possible to read the value of μ directly from the curves, but it is necessary to construct two curves from these, plotting plate current against plate volts. Call the first of these derived curves A, and let it be relative to a constant grid potential of 5 volts positive; then the following set of values will be obtained from the curves of Fig. 13.

Anode volts.	Plate current.
8	0·25
15	0·5
12·2	1·75
28·5	3·5
35	6·5
41·5	9·5

and plotting these we obtain curve A. Similarly, plot curve B corresponding to a positive grid voltage of 6 volts. Both of these curves are shown in Fig. 15.

We have thus made a change of one volt on the grid (*i.e.*, from 5 to 6 volts positive) and can see at a glance the value of the decrease in plate volts necessary to obtain the same plate current at the higher grid voltage.

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It will be noticed that the value μ varies when the operating position on the slope of the curve is altered; in a well-designed valve, however, the maximum value μ_o is where the grid is at zero potential with reference to the filament.

The μ_o of several modern valves is given in the appended list.

μ	Receiving	Transmitting
6	MARCONI V24	—
50	MARCONI Q	—
200	—	MARCONI MT 1

PLATE RESISTANCE.

For low-frequency currents the impedance of the plate circuit—internal to the valve—is in the nature of a pure resistance, and it is only when high-frequency currents are present that the inter-electrode capacity of the valve tends to lower this value. Since we are here not concerned with high-frequency currents, the consideration of R_o will be limited to that of true ohmic resistance. That this resistance of the plate (sometimes called the internal impedance) is a variable quantity will be seen by reference to Fig. 15. For instance, when working with 26 volts on the plate, and with the grid between 5 volts and 6 volts positive, the resistance R_o is

$$\frac{E_p}{I_g} = \frac{5{\cdot}875}{0{\cdot}00033} = 17{,}800\ \omega.$$

but with 37·5 volts on the plate R_o becomes $\frac{6{\cdot}375}{0{\cdot}00039} = 16170\ \omega$. Hence, as the plate voltage is increased, the value of R_o decreases for a given grid voltage.

The necessity of first evaluating μ before R_o can be determined, makes the process a rather lengthy and complicated one, since this involves the plotting of two sets of curves similar to those of Figs. 13 and 14. In order, therefore, to obviate this tedious operation, Stewart Ballantyne (Proc. I.R.E., April, 1919) has evolved a dynamic method for finding R_o directly, based on the bridge principle.

The circuital arrangement is depicted in Fig. 16.

This method has the advantage of simplicity, and a series of curves may quickly and accurately be obtained by its aid. R_1R_2 is a slide wire, and R is a known non-inductive resistance of approximately the same value as the

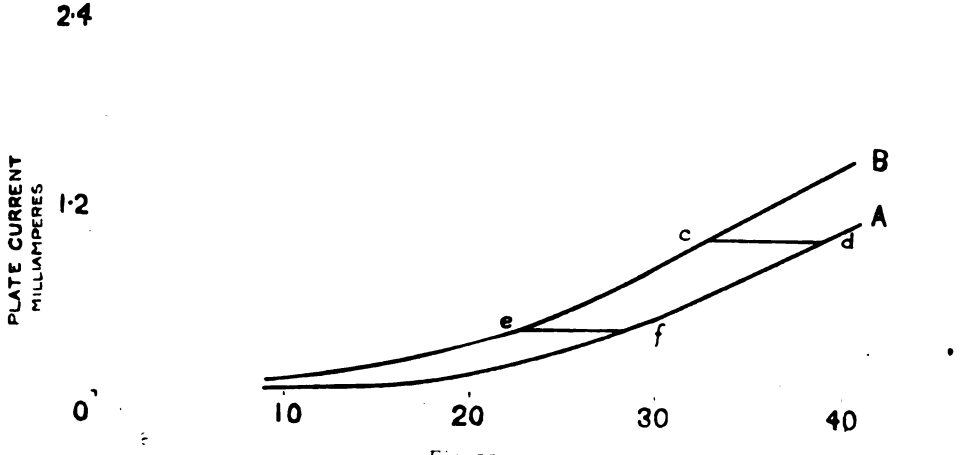

Fig. 15.

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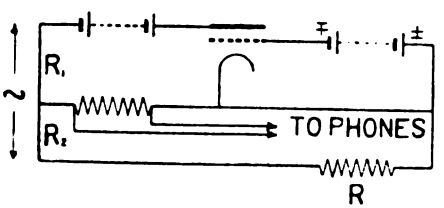

Fig. 16.

plate resistance. The method of operation is as follows: An intermittent d.c. or an a.c. is sent through R_1R_2, and the pointer is then moved along it until the current through the balance lead falls to zero, namely when signals vanish. R_o is then obtained by multiplying R by the ratio $\frac{R_1}{R_2}$. In the compilation of the curves in the concluding figure (17), the source of the current pulses was a high-note shunted buzzer; R_1R_2 consisted of a yard length of number 36 Eureka wire and R of a Remco resistance rod of 19,700ω resistance.

The curve which is of most interest is that corresponding to 50 volts on the plate, since it is almost symmetrically placed with reference to the detecting point. It may appear a little curious that R_o should go up after a certain positive value of grid volts is increased, but this is due to the fact that grid current is flowing, to the right of minimum resistance.

This value of anode volts change, divided by the grid volts change (in this case, one volt), denotes the value of μ at that particular value of plate voltage. In the two cases shown, *i.e.*, $c-d$, $e-f$, the values are 6·3 and 5·9 respectively.

From the case above mentioned it will be seen that letting

V_1 = higher plate voltage.
V_2 = lower plate voltage.
V_g = the change in grid volts

for constant plate current, then

$$\mu = \frac{V_1 - V_2}{V_g} \quad \ldots\ldots\ldots\ldots (4)$$

and substituting in the case $e-f$ (Fig. 15),

$$\mu = \frac{V_1 - V_2}{V_g} = \frac{28{\cdot}5 - 22{\cdot}6}{1} = 5{\cdot}9$$

The method outlined above entails the construction of curves, which occupy a good deal of time in operation and plotting; it may be, therefore, an inconvenient process if an approximate value is all that is desired, and a quicker method may be more suitable. Such a method should already have become obvious to the reader from what has been said. Having ascertained experimentally the point at which grid current starts, note the plate voltage and current. Now decrease the plate volts and increase the grid volts till the plate current has reached its former value. It will be seen that in this operation one is, in reality, selecting the desired points on the characteristic curves, and that values may be substituted in equation (4) and μ be obtained in this manner.

Calculation of μ_o from Valve Dimensions.

The factor μ_o of a valve with cylindrical electrodes may be calculated with accuracy by the formula below, due to Sir J. J. Thomson, to whom thanks are due for permission to publish.

$$\mu_o = \frac{\pi d' N \log\left(\frac{du}{d'}\right)}{\log\left(\frac{1}{\pi dg N}\right)} \quad \ldots\ldots\ldots (5)$$

where

d' = diameter of grid in centimetres.
du = diameter of anode in centimetres.
N = number of turns per cm. length of grid.
dg = diameter of grid wire in cms.

It will be noted that this formula does not include any electrical units, but shows the factor μ_o directly from the dimensions and disposition of the electrodes. It will perhaps be of interest to see how the calculation compares with the actual case of the receiving valve mentioned above. The values are:

d' = 0·32 cms.
dg = 0·023 cms.

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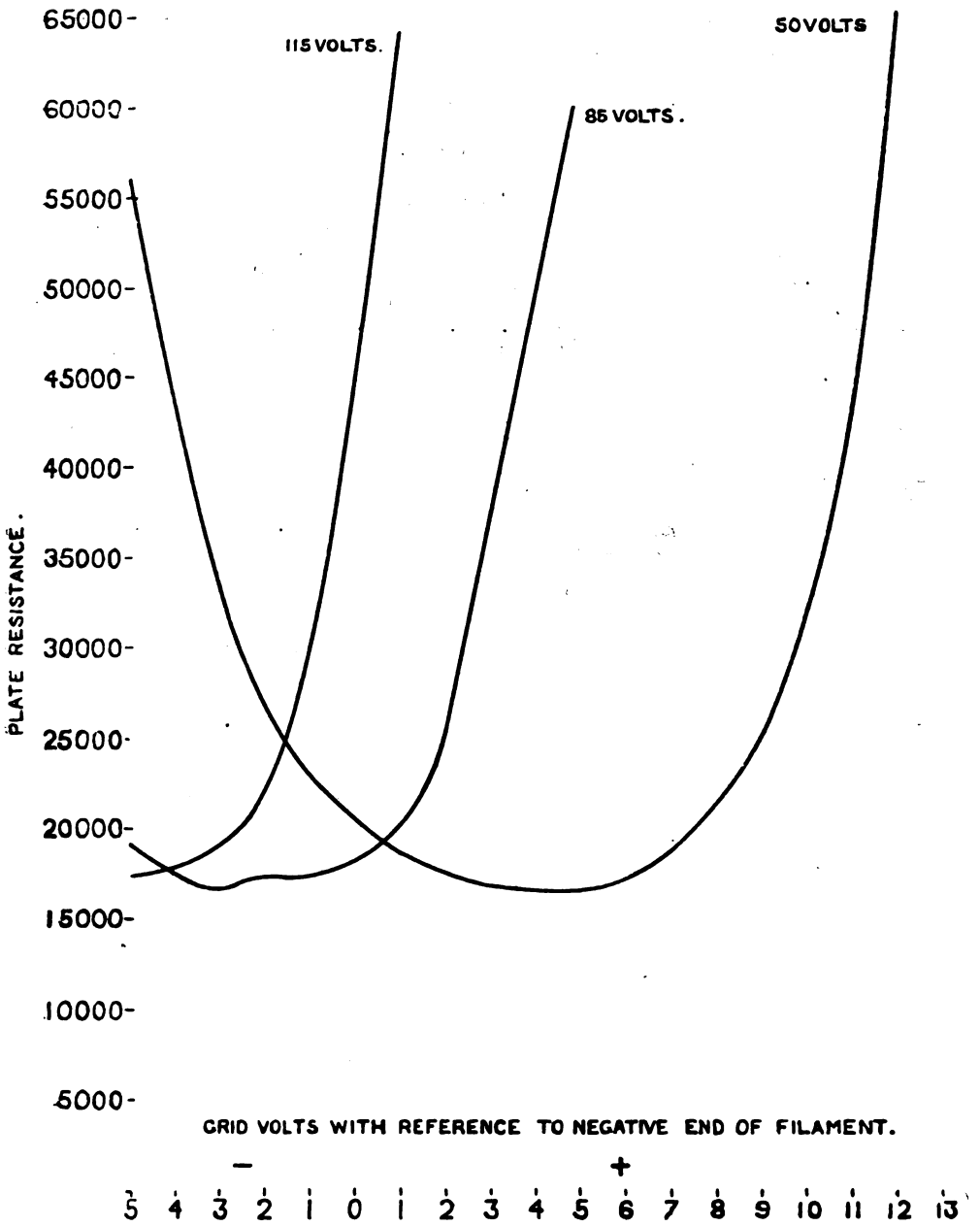

Fig. 17.

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$$d = 0{\cdot}685$$
$$N = 6$$

and substituting in formula (5) and working the numerator first, for the sake of clearness, we obtain

$$3{\cdot}1416 \times 0{\cdot}32 \times 6 \times \log\left(\frac{0{\cdot}685}{0{\cdot}32}\right) = 1{\cdot}99$$

and for denominator we have

$$\log\left(\frac{1}{3{\cdot}1416 \times 0{\cdot}023 \times 6}\right) = 0{\cdot}345$$

$$\therefore \mu_0 = \frac{1{\cdot}99}{0{\cdot}345} = 5{\cdot}8 \text{ nearly.}$$

It will be noticed that the anode diameter, and the thickness of the grid wire, are considered in the equation (5), as indeed they should be; but provided the valve is designed correctly these two values may be disregarded, and the expression

$$\mu_0 = 2\pi r N \ldots\ldots\ldots\ldots (6)$$

will be found to be sufficiently true for practical purposes. The symbols r and N refer to the radius of the grid, and the number of turns on the grid respectively. When the grid is composed of a mesh, the value of μ_0 will be roughly $4\pi r N$, in which case N represents the number of meshes per centimetre.

Other direct methods of obtaining the voltage amplification factor have been devised, such as Miller's (Proc. I.R.E., vol. vi., 1918) and Allen's (WIRELESS WORLD, November, 1918), but reference should be made to the descriptions of these methods as given by the originators. —(*To be continued.*)

The Library Table

THE WIRELESS AMATEUR'S DIARY AND NOTEBOOK.

The Wireless Press, Ltd. 4/6 net.

THIS is an attractive looking production consisting of two separately bound parts inserted in a stout pig-skin folder which has special accomodation for stamps, visiting-cards, treasury notes, and private papers. The first part should go straight to the amateur's heart for it contains just the kind of information he is always asking for, such as a list of the world's chief high-power stations with details of the systems and wavelengths used, much useful data which has been compiled with an eye to what the amateur really needs, and a series of well-drawn typical valve circuits. Space is provided for a directory of amateur wireless stations and for "Receiver Notes" wherein the amateur can jot down the various adjustments of his instruments for certain wavelengths. There is also a 1920 Calendar and a large quantity of directly useful miscellaneous data, followed by a diary and notebook. The second part consists entirely of the ever-useful squared paper. The case measures $3'' \times 5\frac{3}{4}''$ and fits into the average top vest pocket quite comfortably.

THE WIRELESS OPERATOR'S DIARY AND NOTEBOOK.

The Wireless Press, Ltd. 4/6 net.

With the exception of some items which have been specially prepared for the benefit of professional wireless operators, this notebook is identical with the one described above. It contains a list of the principal stations on the ocean routes, a table for calculating tolls on messages, notes on freaks and long-distance communications, and on the best adjustments of the receiver for various wavelengths. It also includes the valve circuit diagrams.

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Notes of the Month

THE STEADY MARCH OF WIRELESS.

The Amalgamated Wireless (Australasia) Ltd. have received an order for a complete wireless installation for direct communication between Nukualofa and Suva.

* * *

The Council of Ministers, Colombia, has approved the terms of a contract for installing a wireless station in Puerto Velillo or some other point on the coast. The plant is to be powerful enough to maintain day and night communication with the station which the Marconi Company is to erect at Bogota.

A station is also to be constructed in one of the islands of the St. Andres and Providencia Archipelago.

* * *

A wireless station has been installed at Cobija, Bolivia, for communication with other parts of the Republic and with Brazil.

* * *

The Venezuelan government has invited tenders for the construction of a wireless station to be situated in the neighbourhood of Caracas, which must be able to communicate with the U.S.A. and Europe. The specification provides for both C.W. and spark systems.

* * *

CANADA—BERMUDA WIRELESS SERVICE.

The Department of the Canadian Naval Service at Ottawa announces the inauguration of a commercial wireless service between Canada and Bermuda. The service will be established by the Canadian wireless station at Barrington Passage, Nova Scotia, and the British Government station at Bermuda.

The Stavanger wireless station in Norway has now been opened. Communication will be held with the Annapolis station at Washington and the Tuckerton station near Philadelphia.

* * *

Restrictions in force during the war with regard to the use of wireless by merchant vessels in Argentine waters have now been removed.

* * *

NEW CALL SIGNALS.

The following alterations and additions are notified by the Berne Bureau:—

FFA	Algiers.
FFC	Bonifacio.
FFH	Le Havre.
FFM	Marseilles.
FFN	Nice.
FFU	Usbant.
FFX	Bordeaux.
FUC	Cherbourg—Rouges—Terres.
FUD	Dunkirk—Castelnau.
FUE	Mengam.
FUI	Ajaccio—Aspretto.
FUK	Aran Ain el Turck.
FUN	Lorient—Pen—Mané.
FUQ	Porquerolles.
FUR	Rochefort-sur-Mer.
FUX	Toulon—Croix des Signaux.

* * *

PUBLICATION OF TECHNICAL W/T ARTICLES.

The War Office states that it has been decided to allow experts (either military or civil) employed on wireless duties in the Army, to write scientific papers for publication in this country. The form of publication may be either by journal or by lecture, provided that no detailed reference is made to Service Sets and that the paper is forwarded through the usual channels to the War Office, whence it will be passed for censoring to the Wireless Telegraphy

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Board. Papers for censorship should be submitted at least a month before it is desired to publish them.

* * *

NEW APPOINTMENT.

Acting Captain J. A. Slee, C.B.E., R.N., has been appointed Technical Superintendent and Adviser on the staff of the Marconi International Marine Communication Co., Ltd.

* * *

I.E.E. AWARD.

The Council of the I.E.E. has awarded the David Hughes Scholarship of £50 to Mr. Bernard Cronin, of the University College of South Wales and Monmouthshire.

* * *

THE HIGH-FREQUENCY RESISTANCE OF WIRES AND COILS.

An interesting paper on the above subject was read by Professor G. W. O. Howe, D.Sc., at the ordinary general meeting of the Institution of Electrical Engineers, held at the Institution of Civil Engineers on Wed., Dec. 17th last, followed by a discussion in which Professor C. L. Fortescue, Dr. W. H. Eccles, Messrs. P. R. Coursey, H. W. Taylor, F. Murphy, and R. C. Clinker took part.

* * *

SUCCESSOR TO SIR OLIVER LODGE.

Mr. Chas. G. Robertson, C.V.O., has been appointed Principal of Birmingham University. He has been Tutor in Modern History at Magdalen College, Oxford, since 1905.

* * *

AWARD FOR PHYSICS.

It has been decided to award the Kastner-Boursault prize for Physics to M. Marius Latour. This gentleman, who is a certificated engineer of l'Ecole supérieure d'Electricité, is well-known in wireless circles for his work on H.F. alternators in connection with wireless telegraphy, and on the thermionic valve.

* * *

WIRELESS TO ROME.

A special wireless service between England and Italy for the use of the newspaper Press was opened on 6th January last by the Marconi Company. This service, authorised by the Italian Government and the British Post Office, was instituted particularly to assist the Italian Press in obtaining prompt reports of the Italian Prime Minister's visit to London. The Marconi high-power station at Carnarvon is being used for the purpose and three hours daily have been allotted for this particular traffic.

* * *

AWARD TO DR. WIEN.

The *Technische Hochschule* of Danzig has conferred upon Privy Councillor Dr. M. Wien, Professor in ordinary of Physics at the University of Jena, the rank of " Honorary Doctor Engineer " in recognition of his achievements in the domain of oscillation phenomena and especially for his discoveries relating to the effect of the quenched spark.

* * *

THE PHYSICAL SOCIETY OF LONDON.

At the tenth annual Exhibition held by the Physical Society of London and the Optical Society at the Imperial College of Science, South Kensington, on January 7th and 8th last, there was a fine display of Wireless Apparatus. The Exhibits included: Thermionic Valves, shown by the Marconi-Osram Valve Co., demonstrating the evolution of the valve.—Direction Finders (Marine Pattern), Measuring Instruments, Various types of Valves, etc., shown by Marconi's Wireless Telegraph Co., Ltd.—Various types of Condensers, shown by the Dubilier Co.,

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Ltd.—Induction Coils and Transformers, shown by the High Tension Co. —Three-Valve Amplifying Receiver and a series of Condensers, shown by Messrs. H. W. Sullivan.—A new Wireless Condenser of extra fine adjustment, named the "Phantom," shown by Messrs. Isenthal & Co., Ltd.—A Series of Thermionic Valves, shown by the Edison Swan Electric Co., Ltd.

* * *

CATALOGUE OF WIRELESS APPARATUS.

It may interest amateurs to know that Messrs. H. W. Sullivan's new catalogue is now in the press and will be ready for issue during the early part of February.

WIRELESS CLUB NOTES.

The Wireless Society of London

The Wireless Society of London will hold its next meeting at the Institution of Civil Engineers, Gt. George Street, Westminster, on January 29th, at 6 p.m., when Mr. R. C. Clinker will deliver a lecture on "A Portable Valve Set and some Properties of C.W. Circuits," which will be illustrated by experiments and lantern slides.

The Presidential Address will take place towards the end of February at the Institution of Civil Engineers. Notice of the exact date will appear in the next issue. Those who were privileged to attend the last Presidential Address given by Mr. A. A. Campbell-Swinton, F.R.S., in 1914, will look forward with pleasure to some novel experiments, with which the President's address will no doubt be illustrated.

* * *

The Burton-on-Trent Wireless Club.

(Affiliated with the Wireless Society of of London.)

On December 17th, 1919, a well-attended meeting was held. Mr. A. Chapman, presiding, stated that a number of books were now available and could be borrowed by members. He also stated that the wireless room was not up to then equipped with a valve, but that excellent reception was, however, being obtained. Four new members were elected. The Secretary announced the affiliation of the Club with the Wireless Society of London.

Mr. A. J. Selby then gave a demonstration of electricity and magnetism with home-made instruments, and Mr. R. Chapman (late R.A.F.), replied to several questions on the higher principles of wireless.

Hon. Sec., Mr. R. Rose, 214, Belvedere Rd., Burton-on-Trent.

* * *

The North Middlesex Wireless Club.

(Affiliated with the Wireless Society of London.)

A meeting of this Club was held on December 31st, 1919, at Shaftesbury Hall, Bowes Park, the President, Mr. A. J. Arthur, being in the Chair. Addressing the meeting, Mr. Arthur announced that it was hoped that the aerial pole would be delivered in the course of a few days, and asked that some members would form a working Committee to look after the erection of the pole and install the instruments. Several names were at once handed in. He then called on Mr. Geo. W. Evans to give his address on the construction of Variable Condensers.

Mr. Evans then gave a most instructive talk, and he having brought a number of variable condensers of different types, members were able to gain a lot of useful information.

The chief difficulties likely to be met with were explained, and the salient points of each type of instrument were pointed out. A short discussion then

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followed, at the close of which Mr. Savage moved a vote of thanks to Mr. Evans, and at the same time drew the attention of those present to the necessity of more lectures of that nature, and asked members to come forward with suggestions.

For particulars of the Club apply to the Hon. Secretary, Mr. E. M. Savage, Nithsdale, Eversley Park Road, N. 21.

* * *

The Derby Wireless Club.
(Affiliated with the Wireless Society of London.)

The Annual General Meeting was held on Jan. 2nd, when the Secretary, speaking on behalf of the Chairman, Mr. S. G. Taylor, who was unable to be present, dealt with the amateur situation and recent developments of wireless. Reviewing the present position of the Club, he stated that the membership is now 58 as compared with the pre-war total of 120; this he attributed to the fact that many of the Corresponding Members had now joined clubs in their home towns.

Regret was expressed that Sir Henry Norman, M.P., was unable to continue as President, and it was announced that Mr. F. W. Shurlock, B.A., B.Sc., has consented to be President for the year. Mr. S. G. Taylor was re-elected Chairman, Capt. W. Bemrose, O.B.E., Hon. Sec. and Treasurer, and Mr. J. Lowe, Librarian. The Committee were also elected, a draft of new Club Rules was submitted and approved, and it was resolved to affiliate the Club with the Wireless Society of London.

The meeting was followed by an exhibition of apparatus. Mr. S. G

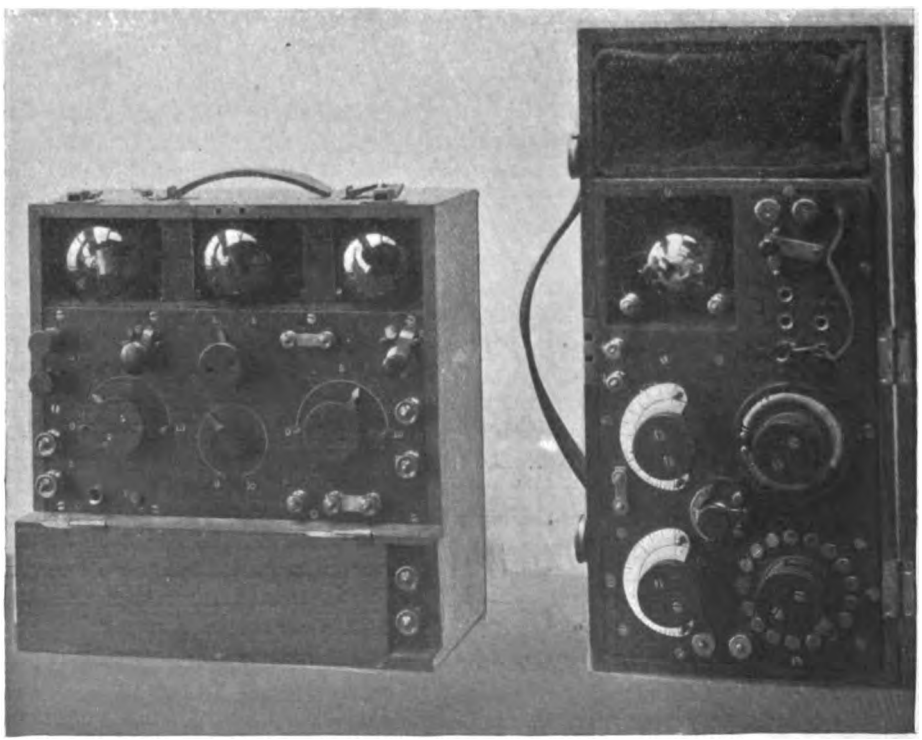

Fig. 1. Portable Receivers exhibited by Mr. A. T. Lee at the Derby Wireless Club.

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Taylor showed, amongst other things, a compact single-valve receiver, the whole of which was contained in a cigar-box measuring about $7'' \times 4\frac{1}{2}'' \times 2''$. Mr. A. T. Lee showed two portable receivers, specially built by himself for use on aircraft (Fig. 1). Capt. Bemrose exhibited a five-valve amplifier of his own construction (Fig. 2), and Mr. J. Huson showed some German variable condensers and other parts of radio apparatus. Messrs. Newton Bros. kindly lent three W/T. generators as used on aircraft.

Fig. 2. Amplifier Exhibited by Capt. Bemrose at the Derby Wireless Club.

The Secretary (Little-over-Hill, Derby) will be pleased to hear from old or intending new members.

* * *

THE MANCHESTER WIRELESS CLUB.

(*Affiliated with the Wireless Society of London.*)

The first General Meeting took place on December 17th, 1919, at the Club Rooms, 335, Oxford Street, Manchester. A large and representative gathering of members was present, most of whom had seen service of an important nature as wireless operators in H.M. Forces.

The Committee has lost no time in getting to work, and already a splendid series of lectures has been arranged for the session.

Through the kindness of the Principal of the Universal School of Telegraphy, the members have been allowed the use of practice rooms and instruments, and also the use of a workshop, which is a great boon to the amateur.

The Club is now open to receive applications for membership, and every help is given to the new *bona fide* wireless experimenter in designing and constructing his instruments.

Morse Code practice takes place every Wednesday at 7 p.m.

Full particulars may be obtained from the Hon. Sec., 16, Hawthorne Avenue, Monton, Eccles, Lancs.

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THE THREE TOWNS WIRELESS CLUB (PLYMOUTH).

December 3rd, 1919—The Chair was taken by Mr. J. Jerritt, and a lecture on "Condensers and their Uses" was delivered by Mr. Voss (late R.F.C.), at the conclusion of which the Hon. Sec. (Mr. W. Rose), drew a number of diagrams illustrating how an ordinary vane type condenser may be specially adapted for valve work.

December 10th, 1919—Mr. J. Jerritt in the Chair. The evening was devoted to Morse practice and a discussion on a variometer brought by the Hon. Sec. and kindly lent by Messrs. Antennæ Instruments, 50, The Promenade, Palmer's Green. Although guaranteed to be efficient only up to 8,000 metres, this instrument worked well up to 10,000 metres.

The club is still waiting for its P.M.G. "permission," as also are some of the members.

The Hon. Sec., Mr. W. Rose, 7, Brandreth Rd., Compton, Plymouth, will be pleased to see visitors or intending members.

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The Wireless and Experimental Association.

A lecture on internal combustion engines was delivered on Jan. 7th by Mr. J. F. Sutton, illustrated with diagrams and dealing chiefly with the smaller types. Reports of the other January meetings will be given in our next issue, as they will not occur until after this number has gone to press.

Intending members please address the Secretary, Mr. F. H. Gribble, 48, Surrey Square, S.E. 17.

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The Sheffield and District Wireless Society.

No reports of recent meetings have come to hand (will the Hon. Sec. kindly note?) but we must mention that we have received a copy of the Presidential Address which was delivered on Oct. 2nd, 1919, by Mr. H. E. Yerbury, M.I.C.E., M.I.E.E., M.I.Mech. E., at Sheffield University. It is a most interesting pronouncement, upon which we congratulate the Society, and we venture to suggest that some of the other Societies would be repaid by devoting an evening to a discussion of the paper. We shall be delighted to lend our copy if others are unobtainable.

Hon. Sec., L. H. Crowther, 156, Meadow Head, Norton Woodseats.

* * *

The Southport Wireless Experimental Society.

Hon. Treasurer and Sec., Mr. Philip H. Christian, 9, Russell Road, Southport. This is a newly formed club, further particulars of which will be published later.

* * *

The Bristol and District Wireless Association.

Will intending members please note that the address of the Hon. Sec., Mr. Alan W. Fawcett, is 11, Leigh Rd., Clilfton.

* * *

Wanted.

Wireless Clubs for Chelmsford, Brighton, Croydon, Birmingham, and Edinburgh. Those interested should communicate with the following gentlemen. Mr. C. E. Jackson, 3, Seymour Street, Chelmsford; Mr. M. G. Foster, Sillwood House, Sillwood Street, Brighton; Mr. A. F. Lake, 318, Brighton Road, South Croydon; Mr. A. H. Staples, Y.M.C.A., Dale End, Birmingham, and Mr. W. Winkler, 9, Ettrick Road, Edinburgh.

* * *

The Liverpool Wireless Association.

Hon. Sec., Mr. S. Frith, 6, Cambridge Road, Crosby, Liverpool.

* * *

Newcastle and District Amateur Wireless Association

Sec., Mr. A. W. Bridges, 53, Greystoke Avenue, Jesmond, Newcastle-on-Tyne.

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Barnsley Amateur Wireless Society.

Sec., Mr. G. W. Wigglesworth, 13, King Edward's Gardens, Barnsley.

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Overseas Radio Clubs.

Holland: The Nederlandsche Vereeniging voor Radio-Telegrafie. Official organ: *Radio-Nieuws,* van Aerssenstraat 162, den Haag, Holland. Membership: *circa* 1500.

United States: The Milwaukee Amateurs' Radio Club. Secretary: Mr. Rudolf A. Teschan, 2319-2329, Wells Street, Milwaukee, Wis., U.S.A.

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The Proceedings of the Wireless Society of London

Ordinary General Meeting held in the Lecture Hall of the Institution of Civil Engineers, on Friday, December 19th, 1919. The President, Mr. A. A. Campbell Swinton, in the Chair.

The Secretary read the Minutes of the last meeting which were duly confirmed.

THE PRESIDENT then referred to the list of members recommended by the Committee for election and now put up for ballot by the meeting. He also announced that three members of the Society had been transferred from the grade of Associate to that of Member. Dr. J. Erskine-Murray then delivered a lecture entitled "The Transmission of Electro-Magnetic Waves about the Earth," which was followed by a discussion. The meeting adjourned at 7.30 p.m. after passing a vote of thanks to the Lecturer.

THE TRANSMISSION OF ELECTRO-MAGNETIC WAVES ABOUT THE EARTH.

BY J. ERSKINE-MURRAY, D.Sc., F.R.S.E., SQUADRON LEADER R.A.F.

IN this paper I want to give you a *résumé* of the state of our knowledge of the conditions in the atmosphere as regards the transmission of electrical waves. Most of our work in wireless is, as a rule, on the actual instruments themselves; but this takes us outside, into meteorology and the physics of the atmosphere. The atmosphere is not very thoroughly understood, though great advances have been made recently; but our knowledge is increasing, and, though it seems rather strange, we certainly have in the past few years learned quite a lot about it from wireless observations.

Now the first—for I am going to inflict upon you more or less the story of the thing from the beginning—the first serious experiments on transmission were made by the late Mr. Duddell and Mr. Taylor, who was at that time a wireless officer in the Post Office. I do not know that they were the first actual measurements but they were certainly the first serious measurements; they consisted of observations of received current by means of the Duddell thermo-ammeter at a station near the pier of Howth, in Ireland, near Dublin. The telegraph ship belonging to the Post Office was fitted with a spark transmitting set, and she sailed in various directions from Howth, including a trip across to Holyhead. Fig. 1 shows by the full lines the actual currents received at Howth when the ship was at certain definite distances, as she was crossing from Howth to Holyhead. There are two lines in the Fig., one showing the received currents for 60 sparks per second, and the other for 40 sparks per second. They are both the same type of curve. The dotted line shows the product of the received current and

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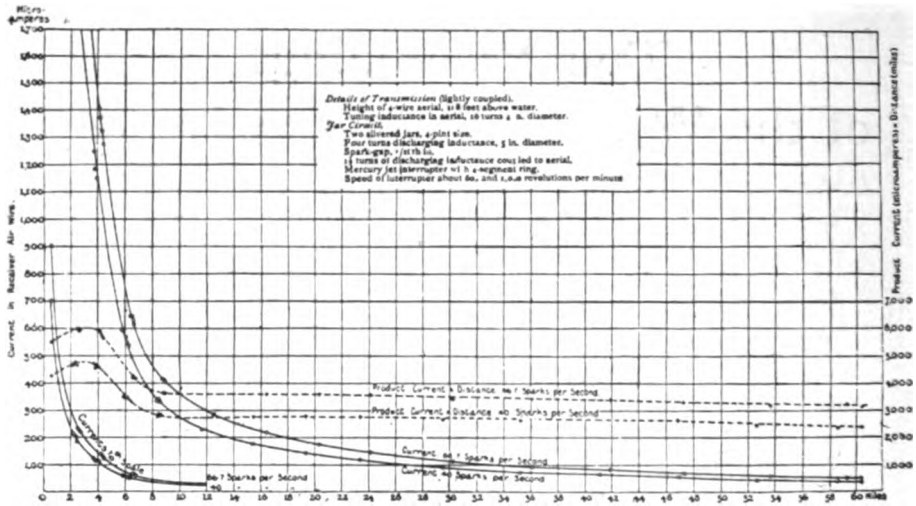

Fig. 1. Received Currents at Howth. Ship crossing from Howth to Holyhead.

the distances between the receiving and transmitting stations. You will notice that for a large part of the course it is nearly a straight horizontal line, that is to say, that the received current was very nearly inversely proportional to the distance. There is a slight drop as you get further away, indicating some kind of absorption. There is a very curious hump between zero and eight miles, which shows something quite different—that is, there is some difference in the conditions for that portion of the course.

Fig. 2 is another diagram relating to the same set of experiments, in which the trip was in a slightly different direction. It shows the same

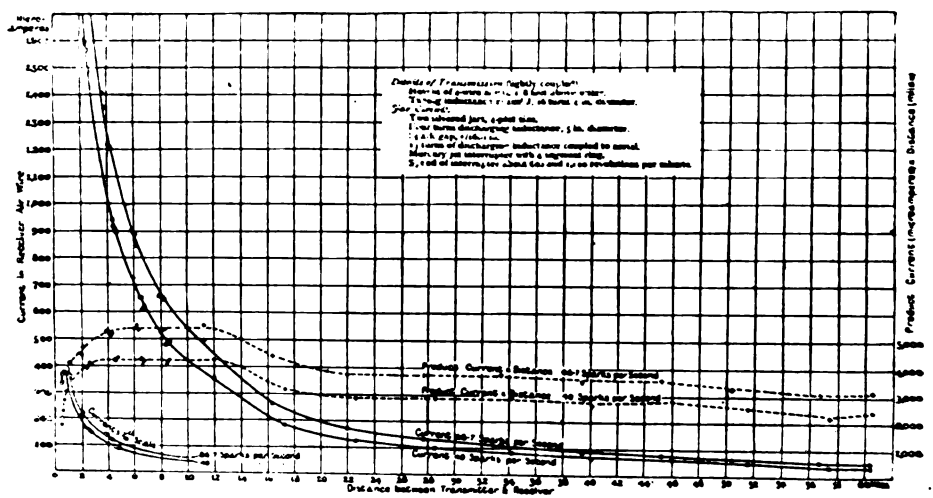

Fig. 2. Received Currents at Howth. Ship returning to Holyhead.

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features: the product of current into distance is nearly constant from about twenty miles to about sixty miles, which was right across the channel, but the hump is very much larger. That is to say, between sixteen miles and the start, there was a very much larger current than would be expected if it were proportional to the distance. That is for the ship returning.

Now I would like to show you what I take to be the meaning of these curves. Fig. 3 shows the tracks of the vessel near Howth. For the first three miles or so on the outward track the signals were very much stronger

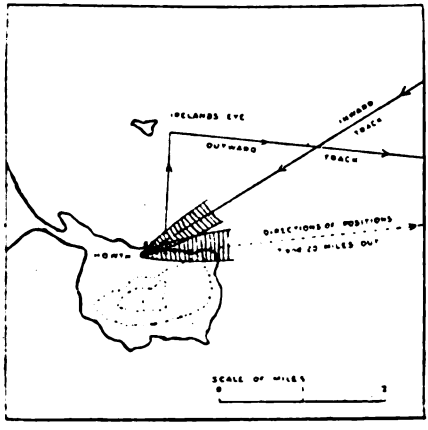

Fig. 3. Useful portions of wave trains arriving at Howth from various directions.

in proportion to those received during the remainder of the outward trip (Fig. 1). The outward track went straight out from Howth pier, turned eastwards, and went on with a slight trend southwards. The dotted line in Fig. 3 shows the direction of the vessel when she was twenty miles out on the outward track, and seven miles out on the inward track. Those were the positions where the sudden transitions took place—the product of received current and distance, from being constant at one value, rose suddenly to a higher value as Howth was approached. For the first portion of the track the signals had to cross practically no land; after the vessel was about seven miles out the signals had to traverse a considerable portion of the land between the station and the eastward coast. The lower shaded area on the Fig. is supposed to represent the waves which really got to the aerial. They scattered a bit because the aerial has a certain height, absorbs a certain amount, and there is a certain concentration. The parabolas bounding the shaded areas—they are approximately parabolas—represent the last parts of the series of waves arriving at the receiving station, and it may be noted that in the case of the inward track, very little of that area is on land (upper shaded area); in the outer track, about half of it is on land (lower shaded area). This makes a difference. All the outer part of the journey of the waves was over sea; but the tail-end receptional part had to pass over about a mile and a half of land before it got to the station. In the other positions, to the northward, there was no such absorption; in the positions southward, there was much more absorption, the product of current into distances being still smaller. This is a practical proof that the ground resistance, especially near the receiver, is of much importance.

Other deductions which I made from those experiments, showed that the actual loss by absorption and the dissipation during the day was equivalent to about 0·24 micro-amperes per mile on a total of 126 micro-amperes at 60 miles. That is hardly a strict mathematical way of stating it but it gives a reasonable idea. During the night the drop was only 0·025 micro-amperes per mile, just about a tenth. Obviously, therefore, there was more

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dissipation during the day than during the night.

The form in which the waves arrive at the receiving station is very important. The effect of the ground or sea is to bend back the wave-front by reason of the waste of energy due to ground resistance. The result of this is that the energy reaches the receiving station not horizontally, but in a downward sloping direction. Hence it follows that this energy must have been transmitted in a direction sloping upwards. The energy which leaves the transmitting aerial in a *horizontal* direction is bent downwards and dissipated in the ground immediately. Thus the energy arriving at the receiving aerial is transmitted mainly through the upper parts of the atmosphere. A series of diagrams has been given by Dr. Zenneck* showing not exactly the form of the waves but how the received voltage varies at a point as a wave passes it. These diagrams, by showing the inclination of the maximum received voltage under different ground conditions, indicate the direction in which the receiving aerial should be inclined in order to obtain the best signals.

Fig. 4 indicates roughly the properties of the atmosphere. The left-hand scale gives kilometres of height. The lower layers of the atmosphere are oxygen and nitrogen; higher up the percentage of nitrogen increases; at about 75 kilometres there is no more nitrogen but there is a little hydrogen. A paper has appeared this month in the *Philosophical Magazine*, in which Professor Lindemann discusses this question of atmospheric composition in connection with magnetic storms and disturbances. He rather doubts whether there is much hydrogen there, partly from the fact that there is not much to be seen of the hydrogen spectroscopic line. The right-hand side of this diagram indicates the atmospheric pressure, but this does not affect us much at the moment, except to show that at the fifty kilometre line you have got a very low barometric pressure and therefore a place where there may be considerable conductivity. Fig. 5 shows to scale the curve of the earth, marked E, and above it the part of the atmosphere which is conductive—not very conductive, but about as conductive as very good clean water. This conductivity is confirmed from the known facts about vacuum tubes. At a pressure such as we get at 75 kilometres up there must be a fair conductivity, especially if there is ionisation, and, in the day-time, ionisa-

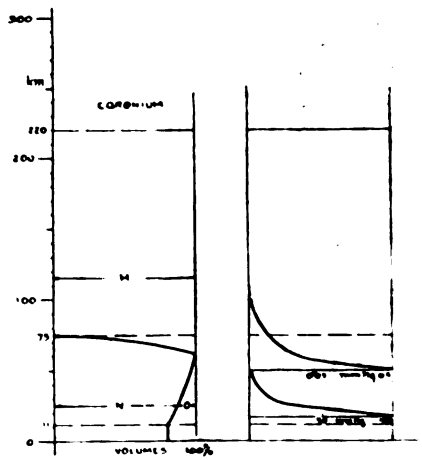

Fig. 4. Diagram showing composition and pressure of the atmosphere at various heights.

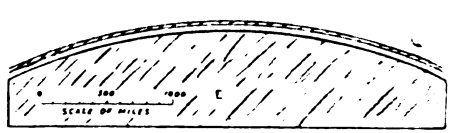

Fig. 5. A portion of the earth and atmosphere to scale. E = the earth; V = outer space, the shaded parts are conductors, the strip between them being the dielectric of Wireless Telegraphy.

* Dr. Zenneck: "Handbook of Wireless Telegraphy."

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tion must be always present owng to the ultra-violet light from the sun, if for no other reason.

The first suggestion of a conducting surface in the upper atmosphere was due to G. F. Fitzgerald, a well-known Irish physicist who made the suggestion in 1893. Sir Oliver Lodge made some experiments to ascertain whether any oscillations could be detected, that might be produced by the concentric condenser formed by the earth and this layer. He could not find any such oscillations. Heaviside introduced the same idea into his article on "Telegraphy" in the *Encyclopædia Britannica*—the latest edition—and Professor Kennelly of America elaborated the idea somewhat later.

Now the next point that we come to is the question of the variation between day and night. This was first noticed by Marconi in 1902. He had an installation on a ship, I think the *Philadelphia*, going across to America, and by day he got good signals up to about 700 miles. By night he got them up to about 1,500 miles, or some such figure about twice as far at night as it was during the day. That was very interesting, and naturally it was put down at first to a possibly less electrically perturbed atmosphere during the night. This was therefore naturally connected with the ionisation of the air by daylight. Much experimental data began to accumulate shortly after that; in particular, observations made by Mr. Edwards, head of the Canadian Government wireless service. A great many observations were published of long distance transmission during the night, or "freaks," as they were called. I put those all together some time ago, and found that it did not matter in which direction you went, or what wavelength was used, these unusually long transmissions could be effected on many nights in the year.

The particular case which seemed to make it perfectly clear that this was due to reflection from the upper layer was one in which there were three stations—Victoria in British Columbia, on Vancouver Island, Pachena Head, on Vancouver Island, about 75 miles away, and a place on another island, called Ikeda Head, four hundred miles away. (Fig. 6.) Victoria transmits to Pachena Head during the day and during the night equally well, but always with some difficulty (there is some local difficulty). Victoria can be heard at Ikeda Head almost every night, but never during the day. If you assume your upper conducting layer as at AB, to act as a reflector during the night, the above is easily explained. Signals from Victoria to reach Pachena Head by reflection from the layer AB, would strike it at the large angle θ. This is not favourable for reflection, especially as the layer is by no means a perfect reflector, but is like the reflection from water or glass. A great deal of the energy will go through. In order to reach Ikeda Head, the waves

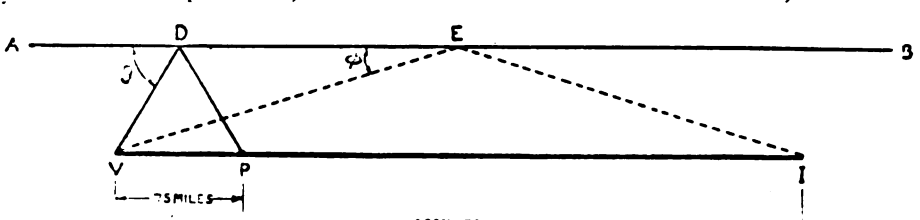

Fig. 6. Diagram of transmission between Victoria, Pachena Head and Ikeda Head Stations.

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will have to strike a point E about 200 miles away. They will graze the surface at the small angle ϕ and the reflection will be good. This explains the fact that signals are received at Ikeda Head during the night, and not during the day—whereas the night makes very little difference to the communications between Victoria and Pachena Head. Many other instances could be given but this is a particularly good one.

Now I would like to mention Dr. Austin's measurements of the energy received at considerable distances over sea by day. He carried out a great many experiments, from the results of which he deduced the following well-known formula:—

$$I_r = 4{\cdot}25\, I_s \frac{h_1 h_2}{\lambda d} \epsilon^{-0{\cdot}0015 d/\sqrt{\lambda}}.$$

where I_r = Received current (amperes)
I_s = Sending current (amperes)
h_1 = Height of sending aerial (kilometres)
h_2 = Height of receiving aerial
λ = Wavelength (kilometres)
d = Distance between stations (kilometres)

It shows the relation between the received aerial current and the transmitting aerial current, the distance and the wavelength. It includes a factor for dissipation, that is to say the loss of energy *en route*. It is interesting to note that Dr. G. N. Watson published only a few months ago a mathematical paper in which he shows that a layer of ionised air having a resistance of $6{\cdot}95 \times 10^5$ ohms per centimetre cube, and a height of about 100 kilometres, will give just the same results as Austin's formula. We have now, therefore, a theory for the Austin formula. This all goes to show with almost mathematical certainty the existence of this ionised layer.

Of course it is not actually a case of reflection in the day-time; it is not a purely reflecting layer. In the day-time it is rather a case of refraction and appears to conform to the explanation which Dr. W. H. Eccles has given of the bending of electromagnetic waves in their passage from a layer of less to a layer of greater ionisation. Fig. 7 gives an idea of what happens when the sunlight strikes the earth. On the left hand is the dark side. The arrows represent the sun's rays. The irregular part of the lower boundary on the right of the layer OPQR is meant to indicate that the ionisation is coming

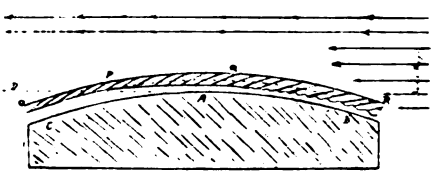

Fig. 7. Effect of daylight on transmission. CAB = earth; OPQR = conducting layer; AD = line dividing sunshine above from darkness below

down nearer to the earth's surface. Towards the left, that is, round to the night, where there is no sunshine, the ionisation dies out and the layer rises, and a clean, sharp reflecting layer is formed at that part.

Many interesting observations were collected together in a paper in the Proceedings of the Institute of Radio Engineers, and show the variations experienced at sunrise and sunset. Dr. Kennelly and others have pointed out that these variations may be due to the approach of that irregular part indicated on the right-hand side of Fig. 7, where the transition from darkness to sunlight takes place. Here there is, as it were, a reflecting wall of ionised gas, which will throw back the signals and disturb them in some way or other. The sudden dips at sunrise and sunset hold practically uniformly for stations in temperate climates.

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Now I come to the work of Dr. De Groot. He has been acting for the last nine or ten years as chief wireless telegraph engineer to the Netherlands Government in the East Indies, and he has had there an opportunity of studying many things which we do not get a chance of studying so well in this country.

Fig. 8 provides a definite proof that the reflecting layer actually exists, and that its height in the tropics is about 180 km. The proofs I have shown so far are satisfactory to most people, but this proof cannot be got round in any way. S represents Sabang on the north-west point of Sumatra. O is Osaka, in Japan. There is about 6,000 kilometres between the two. Sabang is only a five kilowatt station and, in ordinary circumstances during the day, could not be heard above 150 miles. But at the place marked J, which is near Java, S can be heard quite nicely at night. It cannot be heard again at greater distances until Osaka is reached, where it is frequently received at night. That is a clear proof; there is no other way by which the waves could get from S to O without touching P and Q, except by reflection; and, since they were very short waves, and since length of waves—as he afterwards proved—made no difference, it clearly must be a matter of practically pure reflection—reflection from a surface that is a pretty good reflector. Later experiments show that these maxima occur every 3,000 km. right round the dark side of the globe, if the transmitting station be a large one, six maxima occurring between the station and its antipodes.

Fig. 9 is simply a theoretical diagram showing roughly how energy waves from a source S would be reflected from a semi-transparent surface AB. It will be seen that if the waves strike the surface AB at a large angle θ, as at SCD, that most of the energy goes through; if they strike at a smaller angle ϕ, as at SEF, some of the energy is reflected down, as at EG; if they strike at a still smaller angle all the energy is reflected. SHK is the angle of total reflection.

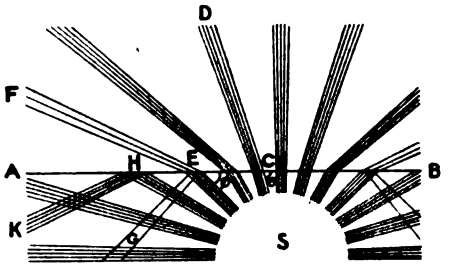

Fig. 9. Reflection of energy at a semi-transparent surface.

We now come to the most interesting part of De Groot's work, which really does throw a good deal of light, when properly understood, on the actual atmospheric conditions. Fig. 10 shows a series of measurements of strengths of signals. The ordinate scale is not actual signal strength, but the values of the shunt resistance connected across telephones—the greater

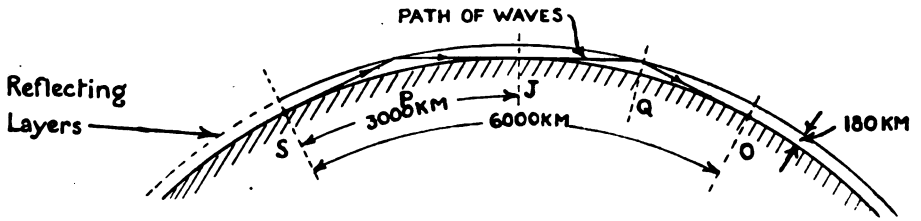

Fig. 8. Diagram of transmission from Sabang.

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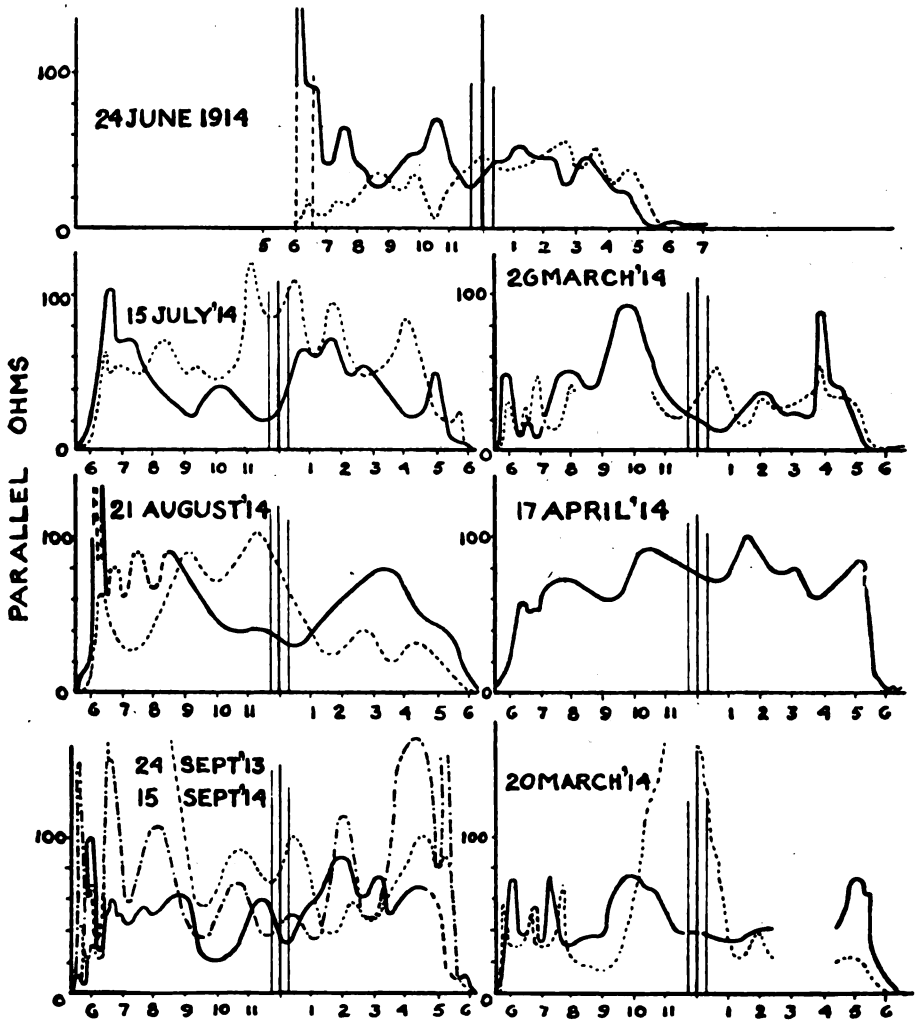

Fig. 10. Series of Signal Strength Measurements.

this resistance, the weaker the signal. Thus the peaks of the curves represent absorption. Generally speaking, it will be seen that in June, during which month the sun is lowest in these regions, there are four comparatively small absorption maxima. As the height of the sun increases from month to month these peaks increase also as the diagram shows. The full line relates to transmission in one direction between two islands about 1,000 kilometres apart. The transmission in the other direction is shown by the dotted line; it is of a similar character but not quite the same. The most interesting part of the picture is for those months in which the sun is nearly vertical. There is enormous absorption at two peaks, one on each side of mid-day, and two other peaks about eight in the morning and half past four in the afternoon. The

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little sunset and sunrise effects which figure so much in this country practically disappear altogether. There is a big variation at 4.30 a.m., which is an hour and a half before sunrise. The minimum of absorption about the middle of the day does not always come at noon exactly. Sometimes it is a little bit on the afternoon side; at other times of the year it comes a little on the morning side. Evidently the whole thing has some perfectly definite relation to the position of the sun, and that is the important point about it.

De Groot has actually worked out the principles of these relations. Fig. 11 is his diagram illustrating what he thinks happens. I may put it this way: during the day the way in which the energy gets from Sitoebondo to Koepang and Amboina—two places, one 1,100 and the other 1,700 kilometres away—is clearly through some upper part of the atmosphere. This is for two reasons, firstly, as we have seen above, the energy that leaves the transmitter horizontally is always absorbed by the earth's resistance, and therefore the energy that actually gets to the receiver must have left the transmitter in an upward direction; secondly, these daily variations, since the sun cannot be imagined as producing large variations in the resistance of the earth's surface. I do not say that the energy is reflected because during the day the quantity of energy which gets from the one place to the other depends on the wave length. This points to ionised layers refracting the waves as they pass from one layer to another. The diagram does not show all the waves that are leaving this sending station; it is simply drawn in order to show that for waves to arrive at the distant receiver they must have started at the angles indicated, because if they did not do so they would be deflected down to the earth again as at T and A'. It should be remembered that the peaks in Fig. 10 were perfectly definite and fairly sharp; they started up in half an hour and went off again in half an hour, which shows that there is not just one layer of ionised air, but layers. This coincides with our knowledge of vacua; the vacuum tube as it is exhausted does not slowly increase in conductivity, it goes in jumps depending on the sudden formation of ions at certain definite pressures.

De Groot found that there were certain definite relations between the sun's position and the formation of these maxima of absorption. He found that whenever the sun was vertical over one or other of four great circles on the earth, the absorption was greatest. Fig. 12 is a somewhat complex looking diagram, but it is a wild attempt to draw planes through great circles and small circles. E is the globe, SP is the south pole, and PP is the path of the sun through W'X'Y'Z'. Over that small circle of the earth the sun is vertical on some particular day—remember those stations—marked S and K—are between the tropics. The great circle through the stations is marked on the diagram. Whenever the sun is nearly vertical over the points

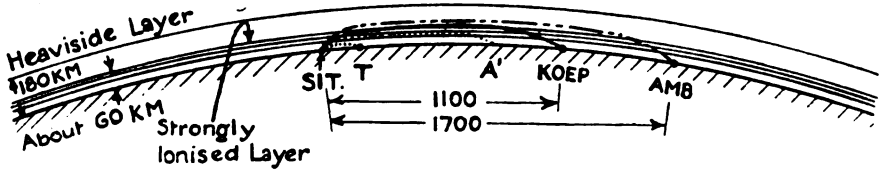

Fig. 11. Refraction of Energy at Ionised Layers.

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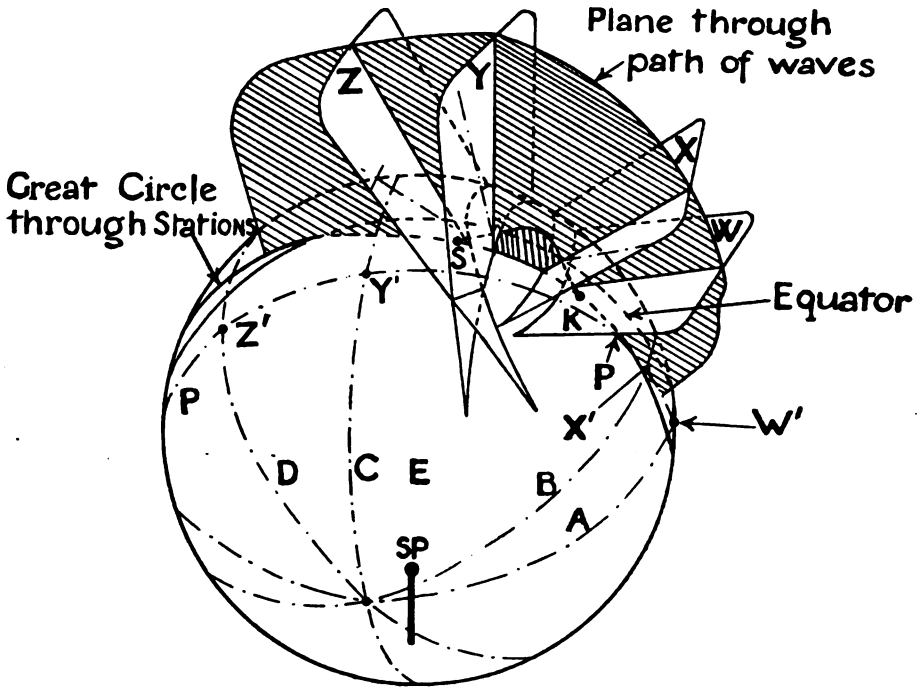

Fig. 12. De Groots's diagram to illustrate his Theory.

W′, X′, Y′, or Z′, there is a maximum absorption. For another day in the year these points might be further up on the four fixed great circles—A, B, C, and D. They are at right angles to the line of transmission (great circle) between the stations and a definite number of degrees away from it—B is twenty degrees east, C twenty degrees west, D forty degrees west, and A forty degrees east. This shows that there is a definite relation between the height of the sun and the absorption of the energy of the waves in passing from one of these stations to the other. The plane through the path of the waves is shown shaded, and the darker shaded portion is the path of the waves from station to station. De Groot raises the question: What can the relation be between the verticality of the sun on this spot of earth and the amount of absorption of energy from a wireless signal passing from S to K? There is this fact; those great circles on which the sun is vertical at moments of maximum absorption are perpendicular to the path of the waves. He asks further: What is the only thing that can be affected? It must be the path of the waves itself.

Let us draw a plane W, parallel to the great circle A which passes through W′. The light of the sun is coming down in that plane, and it cuts the path of the waves as indicated. For one or two days in the year the sunlight will actually come down the centre line of the plane and be in the plane of the wave path itself; at other times it will not come down the centre line but will still be at right angles to some other line which starts from Koepang and rises in the upper atmosphere, and De

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Groot says that this line is probably the path of the actual waves, and that the fact that the sunlight is coming down at right angles to the path of the waves is in some way or other a cause of the absorption. Similarly for the other planes X'Y'Z' later in the day. The plane X corresponding to the position of the sun over X' should be at right angles to another part of the wave path. The sun's rays come down at right angles or some definite angle—he says a right angle—thus there is a definite relation between the direction of the sunlight and the absorption, which probably arises from a definite relation between the sunlight and the path of the waves rising from the one station and descending to the other.

I will conclude with one or two sketches showing what sort of relation De Groot thinks may actually exist. He suggests, of course, that it is probably a variation in ionisation; that is undoubtedly the only thing which we have got in the conditions which *can* vary. Taking mid-day as being the simplest to begin with (Fig. 13); suppose we consider AB to be the surface of the earth, while S is the station Sitoebondo and K is Koepang. The sun is vertical There is no want of symmetry, so that there should be horizontal layers of ionised air, the upper ones no doubt being more ionised than the lower ones. Of course, further up there will not be enough air to ionise, but immediately above the earth, up to, say, sixty kilometres or so, there will be progressively increasing ionisations with, as far as we know, comparatively sharp boundaries between the layers. In order that the waves may get from S to K they must have travelled somewhat as indicated. At mid-day there is not any particular absorption; the waves make a symmetrical course, do not go very high and come down to the station in about as short a way as they could reasonably do.

Take another case, for about nine o'clock in the morning. (Fig. 14.) AB is the surface of the earth; S is Sitoebondo, K, Koepang. The arrows indicate the direction of the sunshine. The ionised layers will be bent down somewhat as shown. The cause of this bending may be seen by reference to Fig. 15 which diagramatically illustrates the shape of the conducting sheil round the earth as modified by the effect of the sunlight. The question arises: How are the waves going to get from one place to the other? Re-

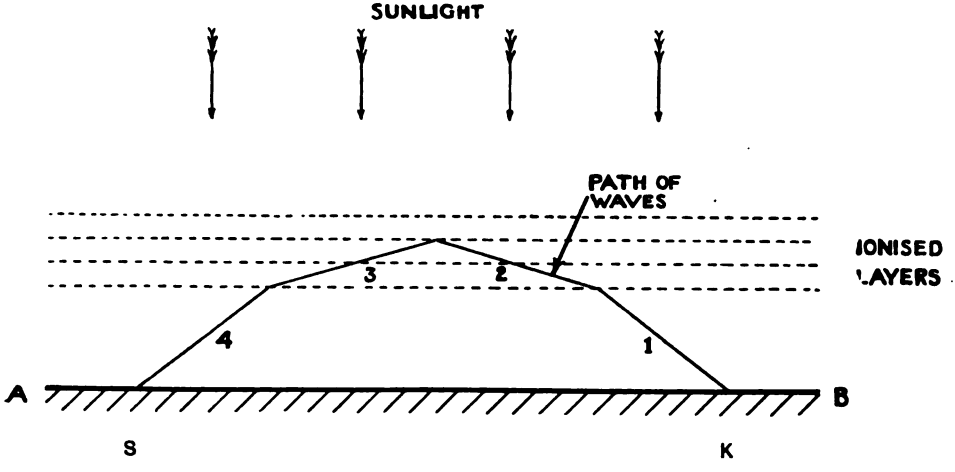

Fig. 13. Refraction of Energy between Sitoebondo and Koepang (noon).

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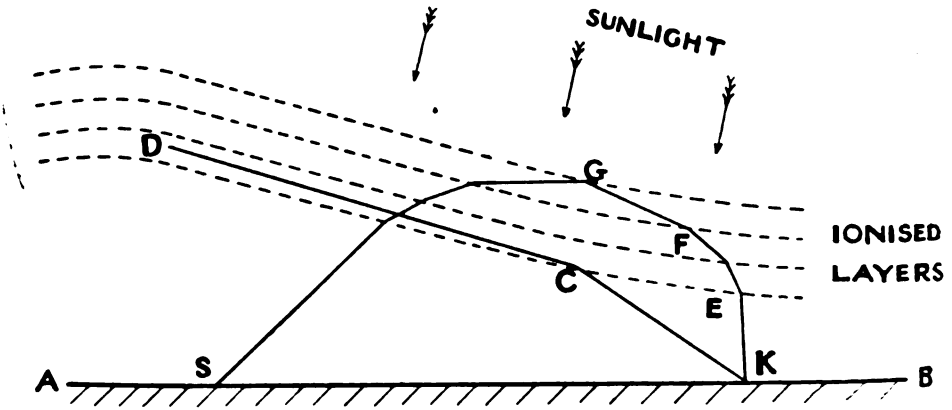

Fig. 14. Refraction of Energy between Sitoebondo and Koepang (10 a.m.) looking North.

ferring again to Fig. 14, let us consider a wave at an angle of about forty-five degrees (as in the case of Fig. 13) to begin with and see where it goes. It goes from K, probably reaches C, gets refracted from there, and goes away between the layers towards D, and is lost. That is the direction of the radiation from the aerial which reached the receiver at mid-day (Fig. 13) but now it no longer gets there. The wave that is going to get to S, starts up at a much bigger angle, something like KE—that is a much weaker wave than the first one, because there is very little energy radiated vertically from an ordinary aerial. KEFG is then the wave that is going to reach S when the layers of ionisation are as shown. If the diagrams for other times in the day were drawn we should find possibly a real explanation of these extraordinary daily variations. I may point out one fact, that during the time when the sun is comparatively low at mid-day, in the cooler season in fact, De Groot obtained sunrise and sunset effects comparable to those of Europe. During the time when the sun is nearly overhead—from November to January—sunset and sunrise effects disappear almost completely, and these hourly variations become very marked.

Most of the foregoing account of De Groot's experiments I have taken from Dutch publications, and in particular from De Groot's "Radiotelegrafie in de Tropen." I hope I have been able to throw some light on the

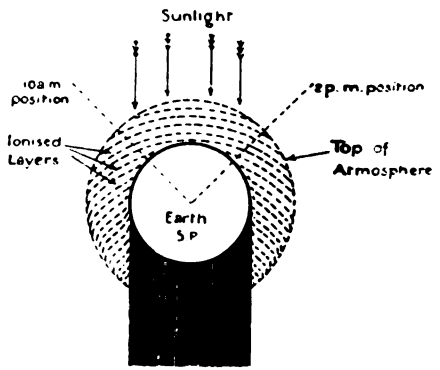

Fig. 15. Distribution of Ionised Layers round the Earth, looking Northwards.

subject, and that you will now be able to follow what is going on in this particular branch of radio work.

DISCUSSION.

The PRESIDENT said he had intended to call upon Professor Howe to open the discussion, but as the latter had left the meeting he would call on Admiral Sir Henry Jackson.

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Admiral Sir HENRY JACKSON: Mr. Chairman, and gentlemen, I do not feel qualified to discuss the paper, but I should like to congratulate Major Erskine-Murray on it. He has put a very difficult question extremely clearly, and I think that anybody who has followed his explanations will now go away with some good clear idea of how it all happens. It has puzzled many of us, I expect, at various times. I have never studied these effects to the extent that he has done, and I go away very much happier than I came in. I must congratulate him on the paper and the way he has put it; evidently there has been a very great deal of work involved in getting the results out from Dr. de Groot's theory. I leave it to more technical people to discuss some of these matters as regards the ionisation of the atmosphere, and the distance the ions can penetrate. I do not profess to know myself, but somebody else can perhaps enlighten us. I think we can all agree that we owe a very hearty vote of thanks to Major Erskine-Murray for his lecture.

Mr. PHILIP COURSEY: I do not think I can add much useful discussion to the very lucid description that Major Erskine-Murray has given us this evening. It is very useful for everyone to have such descriptions of experiments that are going on at the present time, especially when they are published in foreign languages, and in publications such as Government ones, which are not accessible to everybody. I think we must all thank Major Erskine-Murray very much for giving us this excellent description.

Mr. MAURICE CHILD: I noticed that Dr. Erskine-Murray mentioned the fact, on the question of absorption, that freak communications took place in all parts of the world and at all sorts of times. From enquiries that I have frequently made from various operators on ships at sea, I have generally had the information given to me that in Europe the longest distances in which one might say that freak communications took place were generally in the direction of north and south; that no great distance in Europe seems to take place when the signalling is east and west. I do not know whether Dr. Erskine-Murray can give us any information about that?

Mr. J. SCOTT-TAGGART: I would merely like to add a word of appreciation to the excellent paper we have heard to-night, and, perhaps, to ask Dr. Erskine-Murray to let us have some of the practical details of the methods by which these observations were taken. It would be interesting to know, furthermore, what form of detector was used. I understand that the parallel resistance method was employed, and so it was essential that some form of constant method of detection should be used. It would be interesting to know exactly what type of detector was used, and what means were taken to maintain its constant action. I think the subject is of considerable importance to us at present, since most of us are now able to receive messages from America, and these problems of ionisation effects concern us all and not merely those in charge of the higher power stations. Consequently we all look forward to seeing this paper in print, when we shall have a better opportunity of studying it in detail.

A MEMBER: I should like to ask Dr. Erskine-Murray one thing with regard to directional wireless at night; surely there is a certain amount of electrical turbulence? If you have got a station whose direction you think you know in the day time, at night it may appear to move in a clockwise direction or counter clockwise direction. You get extraordinary variations in a very short time indeed; I should say that is possibly due to clouds of ionised gas, or something like that.

Lieutenant HALL: I should like to ask Dr. Erskine-Murray to explain if possible the extraordinary freak transmission in the presence of the northern lights. I have noticed most clear examples in Canada; coming down the River St. Lawrence on one occasion stations with only half a kilowatt communicated with places as far distant as San Francisco. When the northern lights disappeared the stations resumed their normal range.

Mr. W. H. SHORT: Dr. Erskine-Murray has shown us the diagrams of the variations of the signal-strengths for certain months. I take it those diagrams are compiled from a whole series of diagrams taken on consecutive days. There is a gradual change in the position of the peak from the start of the month to the end of the month; I should like Dr. Erskine-Murray to make that clear.

The PRESIDENT: If no one else wishes to speak I would like to add the thanks of the meeting to Dr. Erskine-Murray for his address. I came into the room knowing nothing about the subject at all, but I certainly feel that I know a little more than when I came here. I take it that is the *raison d'être* of this Society. We are all anxious to learn. We are in a rather different position from what we were before the war, because we have now got a certain number of members who know a great deal, whereas others of us know a very little. We are hoping we shall gradually get those who know to impart their information to those who do not.

Dr. J. ERSKINE-MURRAY: In regard to the point that Sir Henry Jackson raised as regards ionisation, I do not think there are any real figures in respect to the upper atmosphere. A great deal of theoretical work has been done, and the latest I have seen is the paper of Dr. Lindemann in the *Philosophical Magazine*, which gives most of the available facts—or approximate facts, may I say—about the upper atmosphere.

As regards north and south freaks, I do not think that there is really very much in this, except perhaps

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near sunrise and sunset. Near sunrise and sunset when the shadow wall is coming along, in all probability there is better transmission north and south than across the shadow wall; but if you were to take the middle of the night, or the middle of the day, you would find freaks going pretty well in all directions. In America the commonest freaks, I believe, are across the continent—that is, east and west. The common direction of freaks is very often simply the common direction of a particular station. A man thinks, for example, that he usually hears freaks in a particular direction because he usually hears Aden; but if there was another station in the middle of the Indian Ocean he might get the freaks from there just as well. Except for the shadow wall, I do not think the north and south direction has any serious relation to the direction of freaks.

The detector which Dr. de Groot used was, I believe, a very carefully constructed crystal detector. He had several, graduated them, kept them in very good order, and used the shunted telephone method for the measurement of signals. Measurements were made day after day, but the actual curves which you see were for particular days—since the curves varied from day to day. One curve was given which was an average for the month. The height of the sun varies from day to day, so it was more scientific to retain the observations of particular days instead of averaging them. Most of the curves were for a definite day, but observations were taken daily, and confirmed that from day to day there was a slight difference in the magnitude and position of this maximum of absorption.

As regards "D.F." at night, I did not mean to give the impression that the upper reflecting layer is a beautiful smooth sphere. A very slight difference in the direction in which the under surface of the upper layer is reflecting would make a very great difference in the way in which the waves would strike any receiving aerial. The explanation of those variations of apparent direction at night may very likely depend upon the fact that the upper layer is not a perfect sphere. I think it is also most probable that some of them may be due to refraction. I pointed out earlier in the paper that Dr. Zenneck showed the energy of the wave was first in one direction, then up to a maximum nearly vertical, and then down in the other direction, so that you had always a turning field at every station, and more at some than at others, depending upon the nature of the ground.

I think there is no doubt about what Mr. Hall said about the aurora giving freak distances. The aurora is certainly an electrical discharge in the upper atmosphere, which is extremely well ionised and acts as a very fine reflector. I think there is no doubt about that, because of the work that has been done alike on the aurora and on wireless. Those are all the points that have been brought up, and I thank you for your appreciative attention. I know the subject is more or less a special one, and I hope in future you will be inclined in this Society to make something of it, because it is the kind of thing that private observers on wireless can do. You can perfectly well go on observing all night if you like. With telephone and ordinary shunt resistances you can observe from day to day. But I do not raise your hopes that you will find these wonderful regular peaks; they are difficult to find because you are not in the tropics.

AMATEURS!

If you wish to enjoy a maximum of freedom to pursue your favourite hobby, and to win for amateur wireless a fitting status,

JOIN A CLUB

HELP A CLUB

OR

START A CLUB

FOR ASSISTANCE OR ADVICE, WRITE TO THE EDITOR.

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Aircraft Wireless Section

Edited by J. J. Honan (late Lieutenant and Instructor, R.A.F.).

These articles are intended primarily to offer, as simply as possible, some useful information to those to whom wireless sets are but auxiliary "gadgets" in a wider sphere of activity. It is hoped, however, that they may also prove of interest to the wireless worker generally, as illustrating types of instruments that have been specially evolved to meet the specific needs of the Aviator.

SHORT-WAVE TUNER, MARK III. (*Continued*).

THE AERIAL CIRCUIT.

As shown in the schematic diagram, given in Fig. 26, this circuit comprises the aerial variable tuning condenser, variable tuning-inductance, and earth.

The condenser is of the movable-vane type with aluminium plates and air dielectric. It is graduated in degrees from 0-180° and has a maximum capacity of 0.0015 mfds.

The inductance consists of seven-stranded wire wound upon an horizontally-mounted drum from which non-inductive leads are taken to 19 studs, giving the following values:—

Stud	1 = 6	mhys.
„	2 = 12·2	„
„	3 = 20·5	„
„	4 = 30·6	„
„	5 = 40·6	„
„	6 = 53·2	„
„	7 = 67·4	„
„	8 = 83·5	„
„	9 = 97·5	„
„	10 = 112·3	„
„	11 = 126·3	„
„	12 = 143·8	„
„	13 = 158·2	„
„	14 = 177·6	„
„	15 = 195·0	„
Stud	16 = 213·4	mhys.
„	17 = 230·8	„
„	18 = 250·0	„
„	19 = 280·0	„

The earth is preferably of the capacity type consisting of one or more copper-gauze mats spread out on the surface of the ground. Both the aerial lead-in and the earth lead should be as short as possible, the former being well insulated and the latter of stranded low-resistance wire.

THE CLOSED CIRCUIT.

The variable condenser is of similar design to that contained in the open circuit, but has a maximum capacity of 0·0005 mfds.

The stranded-wire inductance is wound on a drum of the same size as that used for the aerial inductance, and has five tappings, giving the following values:—

Stud	1 = 13.5	mhys.
„	2 = 23·5	„
„	3 = 40	„
„	4 = 115	„
„	5 = 280	„

This drum is also mounted horizontally, but is rotatable about a perpendicu-

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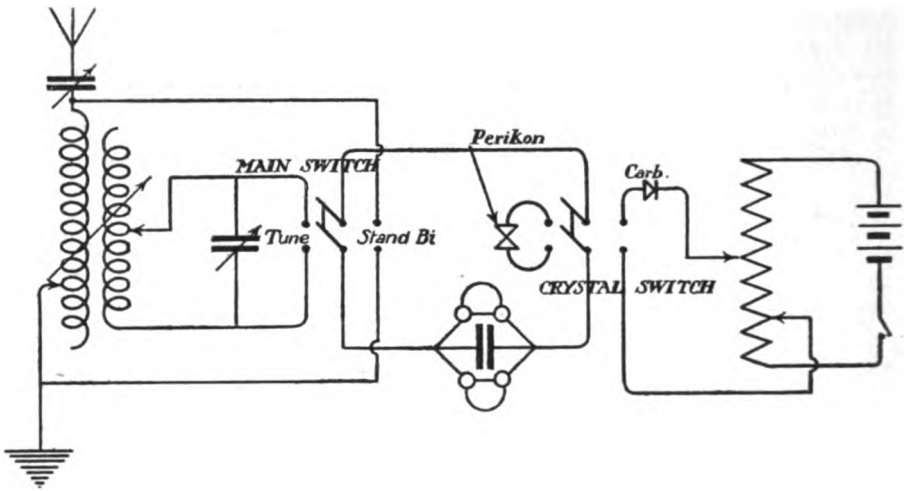

Fig. 26.

lar axis so as to increase or diminish its magnetic linkage with the open-circuit coil, and thereby vary the inductive coupling between the two circuits. This is controlled by means of a handle mounted on the axis of the drum and brought out to the ebonite face-plate of the set.

THE DETECTOR CIRCUIT.

As shown in Fig. 26, either the Perikon or carborundum can be placed in series with the phones at will by means of the " crystal " switch. As a general rule the carborundum crystal is more stable than the Perikon, though the latter is more popular in use as no potentiometer adjustment is necessary.

It is advisable to test the Perikon from time to time with the buzzer, readjusting the contact point between the two crystals when necessary. Sometimes it is impossible to get satisfactory results with any contact point, in which case the crystals are probably "fatigued" and should be replaced by fresh ones. In all cases a light contact-pressure should be used. A forced pressure gives poor results, and, moreover, shortens the effective life of the crystal.

The potentiometer circuit used with the carborundum is fed from a battery of four dry cells giving a potentiometer difference variation of $+3$ to -3 across the crystal. The potential applied is adjusted by means of a handle which controls the position of the variable point along the rheostat. A switch is provided to open the circuit and save the cells from running down when the potentiometer is not in use.

The two pairs of high-resistance phones (4,000 ohms. per earpiece) are used in parallel and are shunted by a small condenser which is inserted in order to compensate for the lag in the passage of the signal current caused by the high inductance of the telephone windings.

The detector circuit as a whole is thrown on " stand by " or " tune " position by means of the main change-over switch.

CALIBRATING THE CIRCUITS.

The buzzer is also used to calibrate the open against the closed circuit with the object of securing rapidity and accuracy in tuning-in.

The closed circuit is first tested against

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a wavemeter for varying wavelengths, the results being recorded, so that a definite series of wavelengths corresponds to ascertained values of closed-circuit inductance and capacity.

Corresponding values of open-circuit inductance and capacity are then obtained by tuning the open circuit against the known wavelengths now emitted by the closed circuit, when set at the previously recorded values of inductance and capacity and excited by means of the buzzer.

This series of results is tabulated on a calibration card so that when a signal is first received on " stand by " the operator will be able by rapidly noting the open-circuit condenser and inductance readings for maximum sound and comparing them with his calibration card, not only to ascertain the signal wavelength, but also to set the closed-circuit condenser and inductance to the correct value before switching-over to the " tune " side, thereby obviating the risk of losing weak signals when changing-over.

Though involving a certain amount of intial trouble, the calibration card was found in practice to be most useful, particularly in the case of operators who were " learning the ropes."

THE SHUNTED BUZZER.

The buzzer itself, as shown in Fig. 27, is shunted across the poles by a non-inductive resistance S. This affords a discharge path for the high e.m.f. induced across the armature winding when each " break " occurs, and prevents a spark discharge between the points, which would in effect prolong the current and so lessen the inductive impulse applied to the oscillatory circuit L.C.

In addition, whilst the contact points are closed, the shunt is in parallel with the high-resistance of the solenoid and thereby allows a higher value of current to pass through the points. As the magnetic field created about the inductance L increases as the square of the current, the extra current passed by the shunt considerably increases the vigour with which the buzzer energises the oscillatory circuit L/C.

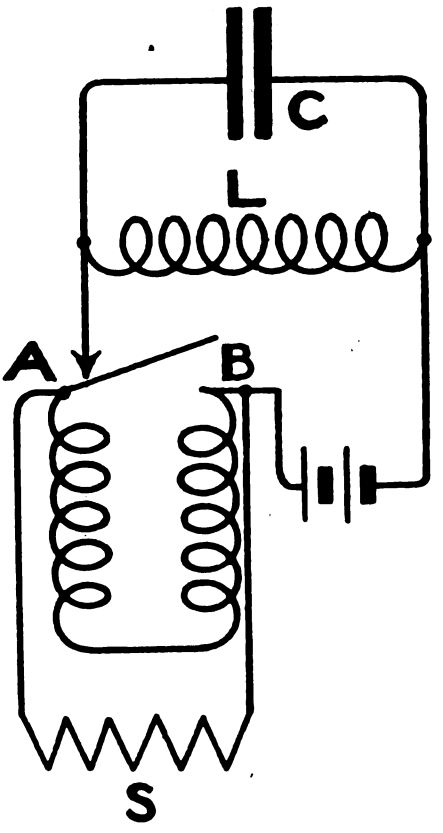

Fig. 27.

Though forming but a comparatively unimportant detail of the tuner, it is as well, perhaps, to have a clear conception of the exact significance of the "shunted buzzer," as owing no doubt to the appealing qualities of the name itself it is frequently and widely applied by experts and others in a sense which, to put it mildly, indicates a regrettable lack of technical precision.

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Aviation Notes

PIONEERS OF THE AUSTRALIAN AIR-WAY.

THOUGH lacking the dramatic elements associated with the transatlantic flight, the achievement of the brothers Ross in linking Australia to the Mother Country by way of the air will probably take equal rank in the annals of Aviation with the exploit of the late Sir John Alcock, of heroic memory, and his gallant comrade.

The outstanding merits of the Australian flight are to be found as much in the intrepidity and endurance of the airmen, as in the triumph of constructive design and workmanship represented by the machine and its engines.

It may, of course, be argued that the flight, which was largely an overland route, became theoretically possible years ago—in fact, directly machines had been designed capable of spanning the relatively short water distances involved. This is true, but it implies the existence of the necessary ground organization, and also of an unlimited number of relay machines and flying personnel.

The great difference, however, that exists between these assumptions and the actual accomplishment of a flight

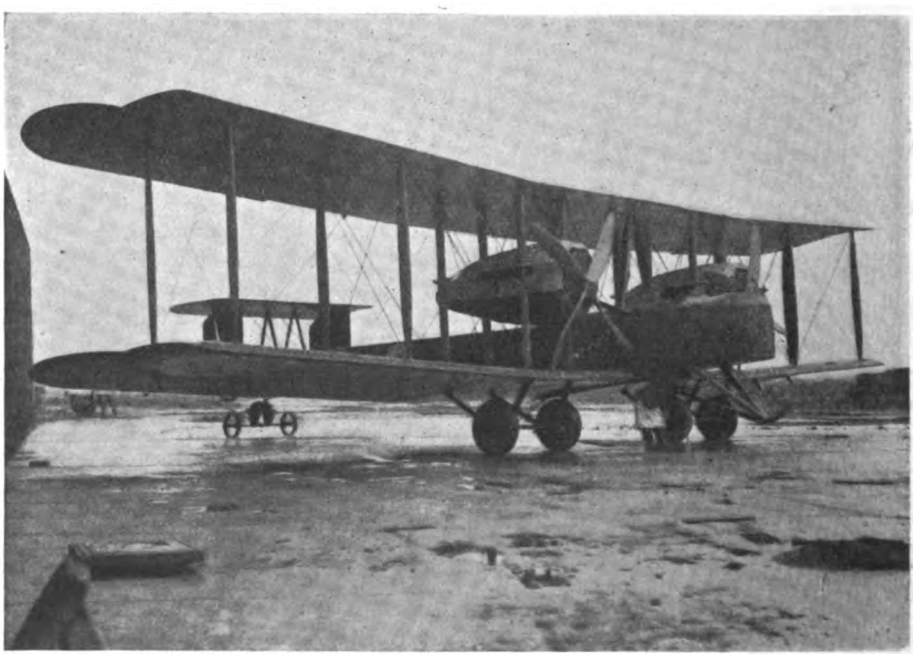

Photo: Photo Press

The Vickers-Vimy Machine.

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Photo: Photo Press

Captain Sir Ross Smith, K.B.E., M.C., D.F.C., A.F.C.

of 11,300 miles within a period of 28 consecutive days by a single machine driven throughout the journey by the same pair of engines and carrying a crew of four, is just the measure of the solid progress that has been made, and equally constitutes a criterion of the credit that is due to the performance.

The King has conferred the honour of Knighthood of the British Empire upon both the pilot and his gallant brother in recognition of the valuable services rendered to aviation by their achievement. His Majesty has also approved of the award of a bar to the Air Force medal in the case of Sergt. Shiers and Sergt. Bennett.

As regards the craft, the laurel leaves again go to the Vickers-Vimy machine and the Rolls-Royce engine. The machine, of which a photograph is given, carried two 350 H.P. Eagle Mark VIII engines, giving a maximum speed of 100 miles per hour. It weighed 3 tons when empty.

The route from Hounslow touched Lyons, Pisa, Cairo, Damascus, Busra, Karachi, Delhi, Calcutta, Rangoon, Bangkok, Singapore, Bima, and thence to Port Darwin. It is unnecessary to chronicle the misfortunes that attended the attempt to continue the journey across Australia, and its subsequent abandonment, since the object of the trip had been accomplished and the prize of £10,000 won when Port Darwin was reached on December 10th.

PAYING THE TOLL.

Unhappily a heavy tribute was exacted before the new air-way had been traversed. It is said that the old

Photo: Photo Prsse.

Lieut. Sir Keith Macpherson Smith, K B.E., late R A.F.

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caravan routes across the Sahara are brazed with the bones of those who have fallen by the way. Similarly a grievous toll of life has been levied by that Arbiter of the Air who guards its ways and appears to view each fresh encroachment of his kingdom with a jealous eye.

We have to deplore the loss to the world of Aviation caused by the crashing of the Alliance "Endeavour" but a few minutes after starting out on the same journey, resulting in the deaths of Lieut. Roger Douglas, M.C., the pilot, and of Lieut. J. S. L. Ross, his navigator.

Another tragedy to be recorded is that of the Martynside Rolls machine which was wrecked off the Island of Cyprus whilst *en route* to Australia. No trace remains of Captain C. E. Howell, D.S.O., M.C., D.F.C., and Air Mechanic Frazer, who formed its crew. Apparently the machine was forced down whilst over the sea by shortage of petrol, and became a total wreck.

Photo: Photo Press.

Sergeant W. H. Shiers, A.F.M.

Photo: Photo Press.

Sergeant J. M. Bennett, A.F.M.

CORRECTION.

In Aviation Notes for December it was stated that the R38 was under completion by Messrs. Vickers. This of course should have read Messrs. Short Bros., who are the builders not only of the R38, but also of her sister airships.

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Pelmanists *v.* Non-Pelmanists.

"I HAVE altered a good deal under the gripping influence of your Course, and continue to do so—I have gained tremendously on the spiritual or intellectual side—and, as far as money is concerned, I am now possessed of a life-long (I am sure it will be life-long) impetus which will make it impossible for me ever to need money. I have earned and gained more cash since I took the Course than during any previous period of the same time.

"We most of us have competitors and rivals—and woe to the non-Pelmanist who tries to run the race and win against a Pelmanist." (F13131.)

The above letter has recently been received by the Pelman Institute. Some may consider it a remarkable letter. It is not a remarkable letter, however, from the Pelman point of view, as hundreds of equally striking letters are received by the Institute almost every day. But it contains certain points which will interest every reader.

MAKING BRIGHT MINDS.

In the first place, it emphasizes the intellectual benefits of Pelmanism. "I have gained tremendously on the spiritual or intellectual side," says the writer. The practical, business, and financial benefits which follow from a course of Pelmanism are so striking that sometimes this particular feature of the Pelman Course is apt to be overshadowed. But it is always present all the same. The atmosphere of optimism, the bright keenness of spirit, developed by Pelmanism is testified to by thousands. Men and women of all ages and professions write continually to say how Pelmanism has benefited them intellectually, how it has given them a new outlook on life, how it has opened to them rich stores of knowledge and enjoyment unknown to them before, how it has rolled away the clouds of depression and unrest from their minds and enabled them to live fuller, richer, and happier lives. The records of the Pelman Institute are full of such cases. The good that Pelmanism is doing in this direction can never be over-estimated or too highly praised.

INCOMES QUADRUPLED.

But then turning to the more practical side of Pelmanism, "I am now possessed of a life-long impetus" says the writer, "**which will make it impossible for me ever to need money. I have earned and gained more cash since I took the Course than during any previous period of the same time.**" This same experience has been that of thousands. Space is inadequate to give the slightest idea of the work Pelmanism doin in

doubling, trebling, and quadrupling the income-earning power

of those who take the Course. In every profession that could be mentioned, in every form of business or industrial work in which people are engaged, there are literally hundreds of men and women who are earning bigger money, holding higher positions, and rising rapidly to the summit of their ambitions entirely through the increased efficiency brought about by a short course of Pelmanism.

165 PELMANISTS IN THE FIRM.

So greatly is the value of Pelmanism appreciated by business men that batches of enrolment forms are constantly applied for by business firms in order that the whole of their staffs may be enrolled simultaneously. Well-known firms have enrolled as many as

165, 145, 100, and 70 members of their staffs in this way at one time.

A well-known business man writes:—

"I do not see how anyone can study the Pelman lessons seriously and not gain thereby, reaping a reward which—besides its definite and, in my case, tangible advantage—also brings with it developments which have no parallel in money values.

"To those of my acquaintances who have been sufficiently interested to ask my opinion of the Pelman training, I have said—and shall continue to say:—

"'Take it—follow instructions carefully—and if at the end of the Course you do not admit having gained something good, right out of proportion to its cost, I will personally refund your outlay.'"

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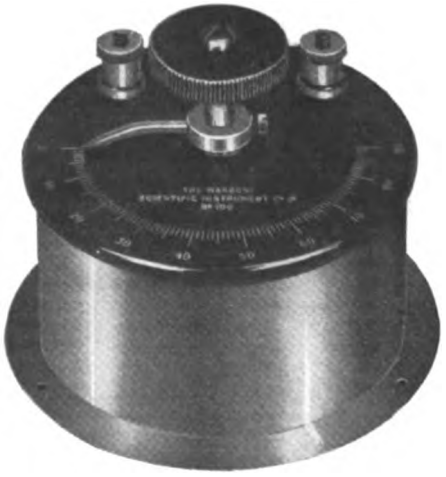

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Notes on the Design and Construction of Valve Amplifiers

By John Scott-Taggart, M.S., Belge E., A.M.I.Radio E.

III.—DETECTOR-AMPLIFIERS (*Continued from December*).

Marconi's Wireless Telegraph Co., Ltd., have evolved a number of interesting amplifier-detectors, and as they are of the class immediately under consideration a short description of their types will not be out of place.

Fig. 12 shows type 55A. It employs seven valves in cascade, the first six of which are high-frequency amplifiers and the last one a rectifying valve. The amplifying vacuum tubes are of the V24 type, where... the last valve is of the "Q" type. The "Q" valve differs chiefly from the V24 in that its grid is of metal gauze, whereas the grid of the V24 takes the form of a spiral wire.

In order to obtain efficient reception over a wide range of wave-lengths, the aperiodic inductance coils are wound with resistance wire to increase the damping effect. In the case of type 55A, the resistance of each coil is 24,000 ohms.

The output circuit of one valve is coupled to the input circuit of the next in two ways. There is the ordinary magnetic inductive coupling, and also a form of resistance coupling. There is in series with the anode of each valve a high resistance, and when the anode

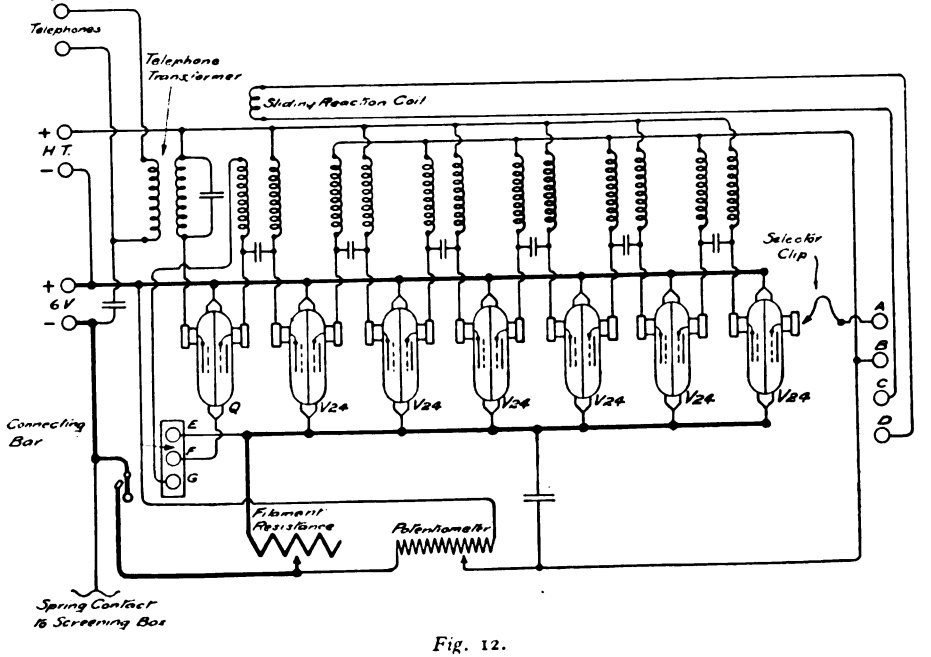

Fig. 12.

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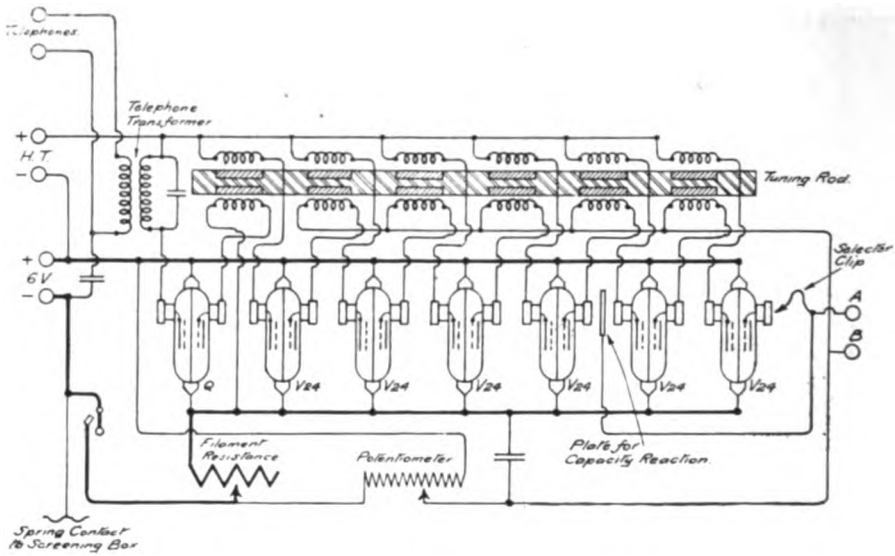

Fig. 13.

current is flowing there is an appreciable potential drop along this resistance. By means of the condenser connected between the transformer windings and the capacity between the windings themselves, variations of this voltage drop caused by incoming signals, are communicated to the grid of the next valve.

The receiving oscillatory circuit is connected across the terminals A and B. A potentiometer is arranged, as shown, to vary the potentials of the grids of the amplifying vacuum tubes, in order that the most suitable operating point may be found. The telephone receivers are connected through the intermediary of a telephone transformer to the plate circuit of the detecting valve which, it will be noticed, does not operate on the leaky grid condenser principle, but because of the asymmetry of one of the characteristic curves of the valve. A selector clip enables any number of valves up to six to be used.

Type 55A works best on a wave-length of 1,000 metres, but will receive signals efficiently on wave-lengths between 500 metres and 3,000 metres. It is interesting to note that the sensitivity of these amplifiers falls off rapidly for wave-lengths below the optimum value, but only slowly in the case of longer waves. As will be seen from Fig. 12, a retroactor coil (or "reaction" coil) may be coupled to any of the transformers to produce retroactive amplification or self-oscillation when continuous waves are to be received. This may be done by removing the connecting bar from terminals E, F and G, connecting E and F together, and connecting the retroactor coil terminals C and D to F and G. The coil is now in series with the grid winding of the last high-frequency transformer. In the case of short waves, retroaction is usually obtainable by adjusting the potentiometer.

Fig. 13 shows Type 55B. The use of a condenser between the transformer windings has now been abandoned, chiefly because capacity effects lessen the efficiency of high-frequency amplifiers, especially when short waves are being received. Type 55B is intended to receive waves having a length of from 100-130 metres. Capacitative retroac-

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tion is obtained by means of a small copper plate inserted between the anode clip of the second valve and the grid clip of the third valve. This plate is connected to the first grid and is suitably insulated.

A special feature is the use of an ebonite rod in which are mounted iron-cores of a peculiar type consisting of cylinders of paraffin wax impregnated with finely-divided iron. By sliding the cores in or out of the transformers close tuning may be accomplished. It would appear that on later amplifiers these special cores are omitted.

A type of high selectivity used by the author during some experiments is shown in Fig. 14. It will be seen that the intermediary transformers are of the loosely-coupled type which eliminate interference to a very marked degree. Consequently, the circuit is really only suitable for reception on a given wavelength, owing to the difficulty of rapid tuning. The circuits should first be tightly coupled and tuned to give the best results. The coupling should then be gradually loosened, the operator retuning, as may be necessary. The grids of the amplifying vacuum tubes have their potential varied by the potentiometer P. Cumulative rectification is used, although the leaky condenser can be dispensed with and rectification obtained by taking advantage of the non-linear characteristics of the grid or anode current curve. Retroactive amplification may be obtained by coupling the retroactor coil L to a suitable preceding inductance. A modification of this circuit consists in making the anode circuits aperiodic and the grid circuits tuned.

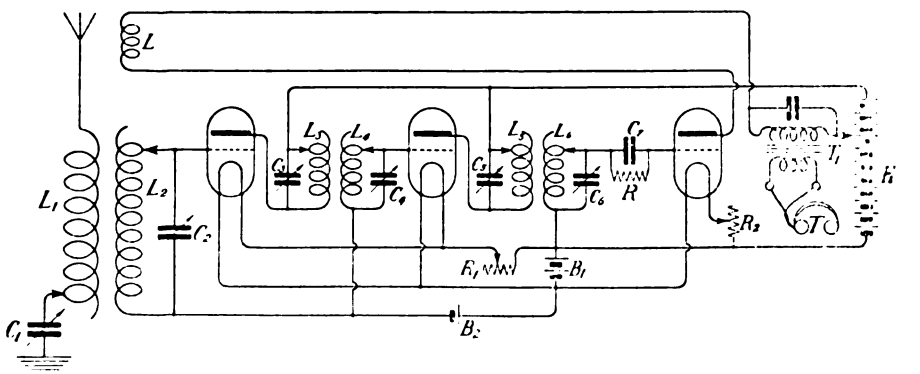

Fig. 14.

(To be continued.)

CORRECTIONS.

In our report of Mr. Scott-Taggart's Paper on a "Syst m for the Reception of Continuous Waves" (January issue), the word "unless" in the second column of page 597 should read "when." In Fig. 1 (page 594), the transformer T_1 T_2 should be shown as a step-up transformer, while in Fig. 3 (page 600) the transformers T_3 T_4 and T_1 T_2 should be of the step-down type.

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The Construction of Amateur Wireless Apparatus

This series of articles, the first of which was published in our April number, was originally designed to give practical instruction in the manufacture of amateur installations and apparatus, and arrangements had been made with Marconi's Wireless Telegraph Co., Ltd., to supply complete apparatus to the designs it was intended to detail. The restrictions on amateur work, however, remained in force, and the author was compelled to proceed on general lines only. A further series will be published giving the class of information originally intended.

Article Eleven.—HIGH-TENSION SUPPLY (*continued*).

THE arrangement shown in Fig. 1 of our last article can be still further simplified by the choice of a valve of suitable design. The working voltage of any practical design of valve is mainly governed by the mesh of the grid. The reader will understand that by "mesh" we mean the spacing of the wires forming the grid; the latter may, of course, not actually be a mesh in the ordinary sense of the word, but may consist of a spiral of wire enclosing the filament. In general, the more open the mesh of the grid the lower the working voltage of the valve. This fact may be utilised in the design of a very simple heterodyne receiver. By opening the mesh sufficiently a valve can be produced which will oscillate satisfactorily with a pressure of only two or three volts applied to the plate. An example of such a valve is the "V24" pattern manufactured by the Marconi Company. In Fig. 1 we illustrate a separate oscillator working on this principle.

In this Fig. A represents the usual oscillatory circuit consisting of an inductance shunted by a variable condenser, the proportions of the circuit being suitably adjusted for the wavelength it is desired to receive. This circuit should have a fairly large L/C ratio. A safe value to take for the maximum capacity of the condenser is ·001 mfd. Of course a smaller condenser will be quite all right, but the capacity should never exceed the beforementioned value or difficulty will be experienced in making the set oscillate. Assuming that the voltage across the filament of the valve, when burning at the correct brilliancy, is about four volts, the accumulator should have an E.M.F. of six or eight volts, the series resistance R being used to adjust the filament current to its correct value. C is the reaction coil connected in the

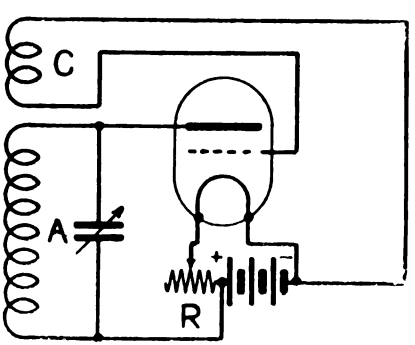

Fig. 1.

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grid circuit of the valve; it operates in exactly the same manner as described in previous articles.

Referring to the diagram it will be noticed that we have connected the series resistance in the positive lead from the battery and that the plate oscillatory circuit is connected directly to the positive terminal of the battery itself. It is therefore clear that the plate will be at a potential of six or eight volts positive to the negative leg of the filament, depending on the voltage of the battery employed for lighting the filament. This voltage is quite sufficient to cause the valve to maintain continuous oscillations in the circuit A when the reaction coil is suitably adjusted. The oscillations produced will not be of large amplitude, but will be quite strong enough to give interference tones with continuous wave signals when the circuit is coupled magnetically with any spark receiver. As a matter of fact a weak heterodyne is an advantage for receiving work. If the local oscillations are too strong the detector may become saturated, with the result that signals will be weakened and may disappear altogether. Also there is less likelihood of interference with other stations owing to the induction of appreciable currents in the receiving aerial (we shall return to this point later).

The same principle can be equally well applied to a self-heterodyne valve circuit. Such an arrangement is illustrated in Fig. 2. This circuit will be seen to be similar to the coupled continuous wave receiver described in a previous article, with the exception that the high voltage battery has now disappeared. It will be observed that we have shown the telephone transformer shunted by a condenser. This condenser is very important. It provides an easy path for the high frequency oscillations past the telephone transformer. Owing to the high impedance of the high resistance winding of this transformer, it is very difficult to make the circuit oscillate unless the winding is shunted by this condenser. A suitable value is about ·003 mfd. This small capacity will not act as a shunt to the low frequency rectified beat current, and consequently the strength of signals will not be affected by its presence.

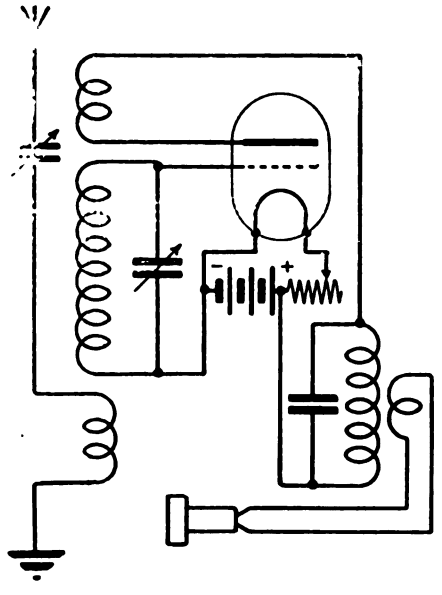

Fig. 2.

Should any difficulty be experienced in getting either of the above simple circuits to oscillate the postive potential applied to the plate should be increased a little. This can be easily done by connecting a four-volt flash lamp battery in series with the plate winding. This battery should be connected at the *bottom* end of the winding, *i.e.*, the negative end of the flash lamp battery should go straight to the positive end of the filament lighting battery. Difficulty will also occur if the insulation of the condenser is not good or

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the coils are damp. It is preferable, if possible, to use an air condenser; and the coils should be wound on highly insulating formers, thoroughly dried out and then given a coat of shellac varnish.

We have referred to the question of interference caused to other stations by a continuous wave heterodyne receiver. This question is very important and we propose to make a few remarks on the subject.

The cause of the trouble will be perfectly clear by a reference to Fig. 5 of Article Eight (November 1919 issue). This Fig. illustrates a direct coupled self-heterodyne receiver, the aerial being directly connected to the grid oscillatory circuit. Now it is perfectly clear that, when the valve is oscillating, an undamped oscillatory current will flow in the aerial during the whole time that reception is taking place. The aerial will therefore be radiating a continuous wave whose wavelength corresponds to the tune of the receiving circuit. This wave will be very weak, because the currents flowing in the receiving circuit are very small; but the sensitivity of a heterodyne receiver is so great that it may be clearly audible at another station several miles distant, and may cause interference if the second station happens to be receiving a weak signal. Also as the receiver condenser is turned round annoying "swoops" will be heard at the second station. It may be that regulations will be introduced forbidding the use of direct coupled self-heterodyne circuits for continuous wave reception.

The trouble can be minimised by the use of the coupled circuit receiver shown in Fig. 6 of Article Eight. When using this arrangement the aerial is tuned to the wavelength of the incoming signal, whereas the grid circuit is tuned to a slightly longer or shorter wave in order to get a beat note. And since the coupling between the aerial coil and the grid coil will be very weak, on account of this mistuning only a very small current will be induced in the aerial itself. Or at any rate, the current in the aerial will be very much smaller than that in the grid circuit of the valve. Consequently the intensity of the radiated wave will be very much less in this case than in that of the direct coupled circuit. The chief trouble experienced with this inductively coupled arrangement is the difficulty of "finding" any station. Owing to the extreme sharpness of tuning of the circuits the condensers have to be very accurately adjusted to get the signals. This is, however, a matter of practice, and the amateur will soon get expert in the manipulation of the circuit when once he has grown accustomed to the circuit. It is very useful when first setting up the receiver to make out a table of condenser adjustments found for different stations. This table can be placed in a convenient position and referred to when it is desired to pick up any station.

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Questions and Answers

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless telegraphy. Readers should comply with the following rules:* (1) *Questions should be numbered and written on one side of the paper only, and should not exceed four in number.* (2) *Queries should be clear and concise.* (3) *Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before.* **(4) The Editor cannot undertake to reply to queries by post.** (5) *All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or if so desired, under a "nom-de-plume."* **(6) Readers desirous of knowing the conditions of service, etc., for wireless operators will save time by writing direct to the various firms employing operators.**

A. E. P. (Manchester) (1).—The reactance of a condenser is defined as the negative quantity $-1/2\pi nK$. The Hawkhead and Dowsett formula $2\pi nL-1/2\pi nK$ which is equivalent to $2\pi nL+(-1/2\pi nK)$, is therefore the sum of the reactance of the inductance and the negative quantity which is the reactance of the capacity. (2) The units in the above formula are Henries and Farads.

S. J. (Solihull) (1).—The capacity of the cylindrical condenser you mention will be about 43 micro- microfarads. (2) A coating of varnish will theoretically slightly increase the capacity, but unless the coating is very thick the increase will be quite negligible.

T.H. (Liverpool) (1).—When an ionic tube is used with a condenser in the grid circuit, the unidirectional current flowing in the grid circuit tends to charge this condenser. If this charge is allowed to build up, the resultant potential across the condenser alters the potential which the grid initially has, and which corresponds to a sensitive point on the grid potential-plate current curve, to a new value which corresponds to a flat and therefore insensitive part of this curve. The tube therefore loses its sensitivity very quickly unless some means of preventing this potential from building up in the condenser is supplied. The most convenient way of doing this is to put a resistance across the condenser by which the charge may slowly leak away as it accumulates.

WABTEE (H. M. T. Aro.) (1).—We think the performance you record probably does approach a record for short power range, although we cannot, of course, say for certain. With amplifying receivers freedom from jamming at the receiving end is one of the most important factors in working long distances, and you were probably exceptionally favoured in this respect. (2) Excluding the watts lost in your 16 c.p. lamp, we do not think that your primary power can have approached as much as 50 watts,—it was probably nearer 20. Your effective aerial watts would not have been more than 10 at most. (3) This connection probably introduces a self-capacity on its side of the buzzer break. This tends to charge up at the instant of break, thus helping to prevent the stored energy of the circuit from discharging as a bad spark across the gap. (4) Dispense with the condenser, and use a telephone transformer. The circuit would tune so very flat that it is not worth while attempting it.

H.V.G. (S. S. Sheafdart).—The station does use a C.W. arc for most of its traffic. The tearing tone at short distances is common, and is due to variations in arc discharge. The higher pitched note is not so common. As you apparently only hear it at short distances from the connections you mention it may be due to forced oscillations in the receiver setting up beats with the incoming radiation. As you do not say whether the pitch varied with the tuning, we cannot say for certain, and this may also have been due to irregularities at the transmitting station.

SPARKS (Plymouth) (1).—220 volts A.C. is quite unsuitable for grid potential of a valve, even with a lamp of any size in series. (2) The design of a wireless telephone set for a given range and a given aerial is rather outside the scope of these columns. The loop aerial you suggest is quite unsuitable. If you must use a loop, use a former several feet in diameter. The T aerial would be fairly suitable. For details of suitable circuits see Goldsmith's Radio Telephony, or Bucher's Vacuum Tubes.

A. E. B. (Welling) (1).—The aerial would be suitable for short wave stations at not too great distances. It would be very little use for large stations on long waves without complicated and expensive apparatus, and a great deal of skill in manipulation. (2) No 24 wire would be quite suitable for the inductance, but you would probably not want as much as you suggest for the wavelengths for which your aerial would be suitable. (3) The sketch you give is fairly suitable for an elementary receiver. (4) Ordinary phones are

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suitable for wireless work *if* they are of suitable resistance,—*i.e.*, about the same as the detector in use. Most crystals have high-resistance and therefore need high-resistance phones. Unfortunately most ordinary phones are low resistance. (You should consult a book such as Bangay's "Elementary Principles," in which you will find the answers to most difficulties such as these which bother beginners.)

GADGET (Bournemouth).—The condition for the oscillatory discharge of a condenser is arrived at mathematically, roughly, as follows. The differential equation for the variation of the charge can be written down from first principles, and is :—

$$\frac{d^2q}{dt^2} + \frac{R}{L}\frac{dq}{dt} + \frac{q}{LC} = 0$$

Solving this by methods given in any book on differential equations, we get

$$q = Ae^{\left(-\frac{R}{2L} \pm \sqrt{\frac{R^2}{4L^2} - \frac{1}{LC}}\right)t}$$

Now this is the equation to an oscillatory quantity if, and only if, the expression in the bracket is imaginary ; and from fairly elementary algebra, this is the case if

$$\frac{R^2}{4L^2} - \frac{1}{LC}$$ is negative, *i.e.*, if

$$\frac{R^2}{4} < \frac{L}{C}$$ or, if $R < \sqrt{\frac{4L}{C}}$ which is the required condition.

M. D. M. (Cricklewood) (1).—An inductive reaction coupling, though very convenient in practice, is not essential for producing oscillations. Oscillations can be sustained by any means by which the change of the plate current can be made to affect the potential of the grids provided that the sense in which the potential is changed is such as to assist the changes in the plate current and not to damp them out. Thus in your first example the grid potential will vary with the charge on the A.T. condenser, which in turn will vary with the plate current. The circuit will therefore be capable of oscillating. It can then be tuned for the local oscillations to beat with the oscillations induced by the incoming waves. Your circuit 2 probably oscillates owing to the connection between the plate and the grid circuit condenser when the ultra-audion switch is closed. We do not think it likely that it would oscillate with this connection broken, at any rate with hard valves. (2) We believe so. (3) This article duly appeared in the WIRELESS WORLD, Vol. V., p. 280. (4) The scheme for charging cells from a vacuum tube rectifier is practicable, if a suitable valve is used, as for instance the Tungar bulb of the B.T.H. An ordinary valve as used in receiving circuits would not pass enough current.

J.S.F. (Herne Hill).—We do not think the scheme of connections you suggest would give good results, and it differs so much from usual practice that we could not give the best values for the inductances and capacities—particularly as you do not give the dimensions of the aerial you propose to use, or the wavelengths you wish to receive. We recommend you to try one of the more usual circuits to begin with.

NEMO (Aberdeen) (1).—Auto transformers would not be suitable, as their use would put comparatively low-resistance paths between the positive end of the H.T. battery and the filaments. (2) The exact value for the condenser is not important—try 0.25 mfds., variable in a few large steps. The circuit could be adapted for note magnification by substituting an iron core transformer for the second H.F. transformer shown. A telephone transformer would also be necessary in the plate circuit of the third valve with low resistance phones.

J. W. (S. S. Mahsud) (1).—In view of the very high resistance of the grid leaks, we do not think that the introduction of a battery in the manner you suggest would be of any use. It would certainly not increase the ease of control. (2) About 10,000 to 20,000 ohms. Such crystals can be used as grid condenser leaks, but would not have high enough resistance for the circuits in the diagram you mention. (3) The circuits of the amplifier are quite different, (vide Fleming's new book). The amplifier should, of course, be used with suitable receiving circuits, and is then quite reliable.

TRAMP (Birmingham (1).—The poles you describe would serve very well for masts for an aerial. Sink them in concrete sockets to a depth of about 3 feet below the level of the ground, tar or otherwise protect the earthed ends, and stay the poles securely from about 35 feet up. Use four stays with their anchors at the corners of a square with 25ft. sides. (2) We can give you no idea of the cost of the apparatus you mention and advise you to apply direct to the makers.

G. W. (Preston).—Your question is so very comprehensive that it is difficult to answer briefly. We think, however, that you would have little difficulty in obtaining a position as a sea-going operator. Posts ashore are not so easily secured, as there are fewer available. It will save time if you write direct to the wireless companies.

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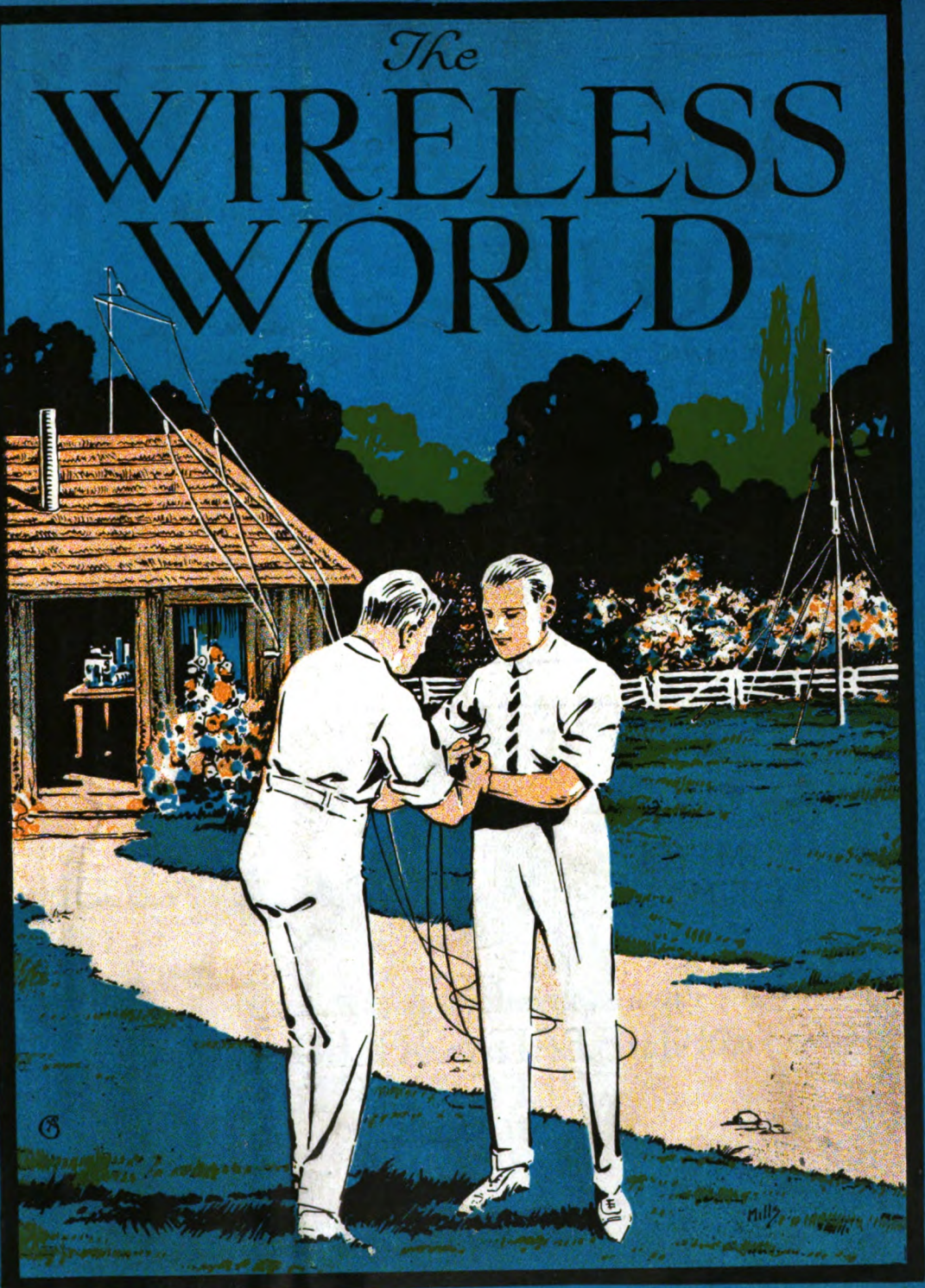

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THE
WIRELESS WORLD

No. 84
Vol. VII

MARCH
1920

Wireless Telegraphy in the Red Sea during the War

By COMMANDER G. MONTEFINALE (Royal Italian Navy).

THE Christmas of 1916 was approaching when I received an appointment for Radio service in the Red Sea and was obliged to leave my wireless work at Brindisi, and many Allied and Italian comrades, and the hard daily duty of wireless communications across the Lower Adriatic, the Ionian and Aegean Seas.

The intensified campaign of Hun piracy in the Aegean and the Otranto Channel obliged the Allies to establish many Wireless D.F. stations, of the well-known Bellini-Tosi type, along the coasts of the Adriatic and Ionian Seas, at Malta and in some bases of the Near East, and for many months, in good and bad fortune, British and Italian radiotelegraphists had worked together in the daily routine of the fleet as well as in the hunt for enemy submarines.

The mail steamship that carried me to Dark Africa went circumspectly out from the harbour of Syracuse, escorted by two Italian destroyers. Many enemy submarines were reported at work in the high seas and we received instructions to steam for Corinth Canal. We entered safely the Patrasso Gulf as the sun sank amongst the Morea Islands. The following day we passed between the rocky walls of the Canal and when later we were in the open sea we found a very dangerous Archipelago, with a freezing, northerly breeze and heavy sea. These constituted the best assurances against the Hun's attacks.

For two long days we steamed alone, dominated by uncertainty, while many enemy pirates were reported by our wireless operator to be in the vicinity. Several times a day the Captain was obliged to alter the course of the vessel.

At last, in a pale, fresh day-break, tinted with some of the characteristic colours of the oriental skies, the passengers crowded on the deck cheered the long-desired land of Egypt. Coasting at full speed along the mouths of the Nile, we dressed our bow to the

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white tower of the Port Said lighthouse arising from the sands, and I read in every passenger's face a profound sense of joy and satisfaction when, passing the Lesseps statue, we left behind us the faithless Mediterranean! But alas! A big Russian cruiser, just clearing the harbour, struck a mine and blew up at a short distance from the beach and sank with all hands! Our joy was very soon changed to sadness, at this unexpected event.

It was the seventh time that I had passed through the Suez Canal bound to East Africa, but I took the same interest in the beautiful scenery and life of the great water-way. In the winter of 1917 the signs of the Great War in the Canal zone were not so imposing as in 1918, in the course of which year a powerful military base sprang up on the sands of El Kantara. Many cargo-boats were steaming along the Canal or waiting in the Ismailia lake, but one met very few mail and passenger liners and these were crowded with white and coloured soldiers instead of happy homeward-bound civilians. Some wireless masts rose from the sands amongst the far distant hills of the desert showing where the Australian and English trenches for the defence of the Canal zone were situated; gun-boats and monitors of the R.N., carrying huge guns on board and fitted with large aerials, were inspecting the Canal and Bitter Lakes shores at low speed, while their W/T. stations maintained constant communication with the Army field stations. Squadrons of the Indian Cavalry patrolled the plains, and in the ravines where the barbed wires extended their ramifications, the Australian soldiers casually took their baths.

Entering the Suez roads we met a big three-funnelled British cruiser bound north. The passengers and a crowd of native soldiers on our deck cheered the flag of our gallant allies. The cheer was renewed when we passed the Italian warship, *Calabria*, lying at anchor before the picturesque beach of Port Tewfik.

In the peaceful Suez roads I found and could admire once more the charming coloured Egyptian sunsets and the brightness of the sub-tropical nights. I saw, as in peace time, big liners and deep-bellied cargo boats passing by my ship: the former crowded with Indian and Australian troops, the latter filled with the Karachi and Industan corn and

A ship in the Suez Canal.

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A British Cruiser going North through the Suez Canal.

the rice of the Far East. No more, as in the piping times of peace, the shining of electric lights on the decks, and the saloons peopled with passengers; no more the echoing orchestras on the placid waters of the Gulf. Silence and discipline ruled those vessels as the trenches of war ruled the world.

When the steamer went beyond Cape Zaffarana one splendid morning when the rocky chain of Gebel was painted a living red by a brilliant sunrise over holy Sinai, we entered the open Red Sea, in a good winter breeze from the North. We then began to hear in our crystal receivers the feeble voices of British and Italian shore stations. The first was that of Port Sudan, giving to the ships in the Red Sea and to the opposite station of Jeddah a "Press Bulletin" of the war. Then we could read the signals of Massawa, launching on her four thousand metres wave the Italian Official, and the Aden Marconi station, transmitting Reuter news.

From that day—January 10th, 1917,—and for two long years, those war bulletins became familiar to me and my companions, during our hard wireless work in that tropical climate, and they were the only recreation which relieved the monotony of our life.

When we reached Massawa, a picturesque little town, hidden at the bottom of the Dahlac Channels and built on some coral islands at the foot of the Abyssinian highlands, it was possible to observe all the changes imposed by the Great War on the local life and trades. The fine harbour was quite empty of steamers and of those characteristic dhows, fitted with lateen sails and handled by natives, that in ordinary peace times crossed the Red Sea in all directions, trading with the ports of Africa and the Arabian coasts.

Now that trade had ceased as a consequence of the British blockade of the Yemen and Asir coasts, and of the guerrilla warfare in the interior of Arabia.

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It was my particular task to organise the Wireless-telegraphy service of the Italian naval and shore stations, in conjunction with the Senior Naval Officers and the Resident Naval Officers of Aden and Suez, following the rules of the inter-allied books.

The Massawa High-Power station was linked with the Marconi stations of Aden and Abu-Zabel (Cairo), which latter was in direct communication with Rome (Centocelle). The station of Mogadiscio in Italian Somaliland (fitted with 100 kw. Marconi set), which had been linked with Massawa in 1911, was put in communication with British stations and authorities in Jubaland and the B.E.A. settlements. This organisation was very useful for the rapid signalling of the presence of German corsairs in the waters of the Indian Ocean. The allied flotillas in the Red Sea and in the Gulf of Aden received even more useful services from the 30 k.w. Marconi station of Assab, constructed just at the beginning of the war, by the Italian Navy, under enormous difficulties.

The Naval Radio Station of Assab acted as a relay between the English and Italian cruisers at sea and the shore stations of Massawa and Aden. For long weary months, in the cool and in the hot seasons, through good and bad fortune, British and Italian operators, in the common round of the daily work of wireless communication, became familiar with each other by means of the ætheric link between them. Far from their menaced countries, in a climate which is always unhealthy for white people, they accomplished difficult tasks like their companions in the Mediterranean and the Adriatic, but with much more modesty in what was, perhaps, believed not to be a real war-zone. Maintaining continuous radio communication at short and long distances is an uncommon duty for radiotelegraphists in the tropics, but this duty became absolutely arduous in the Southern zone of the Red Sea, which is included between the Sana highlands on the Eastern side and the Erythrean and Abyssinian ranges on the West. Here the atmospheric disturbances due to the terrific storms of the rainy seasons add their effect to the "strays" which Dr. De Groot affirms to be of an extra-

Massawa. A picturesque town built on coral islands.

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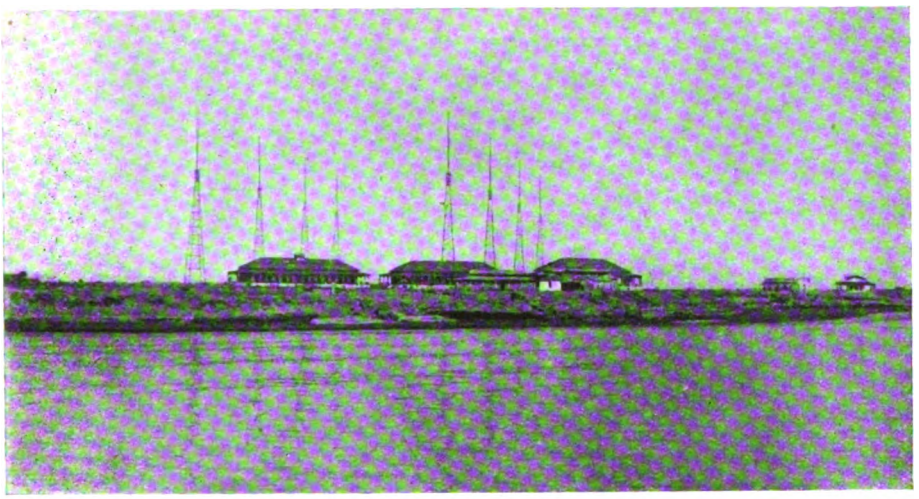

The Massawa Wireless Station. 150 K.W. Marconi type.

atmospheric origin, and which are more intense in the afternoons and in the summer season.

In March, 1917, the Massawa station, which was already linked with the Marconi High-Power station of Coltano, near Pisa, was put in touch with a newly-opened station at Taranto which was fitted with the Poulsen arc. In the summer the same station was put in communication with the new continuous-wave station of Rodi. By means of Taranto and Rodi the communications with Italy were more efficient, especially in the bad season.

One of the more appreciable benefits of long distance radio-telegraphy during the War was the possibility of receiving, in savage Africa, the Official Bulletins and all other news radiated by Allied and enemy long-range stations in Europe. At Massawa it was possible to receive every day official and press messages transmitted by Malta, Horsea, Carnarvon, Paris, Lyons, Coltano, etc., as well as the propaganda telegrams of Nauen, Eilvese, Pola, Sayville and Tuckerton. All the war news received in the course of the day was gathered together in a small official newspaper printed by the Erythrean Government and widely distributed amongst the Italian and native people of the Colony. Some extracts from it were daily wirelessed to the Italian Somaliland stations, to ships at sea and also to the Italian Legation in Addis Abeba, where I had established the first W/T. receiving station of the Abyssinian Empire.

In November, 1917, the powerful voice of the new big station of Rome (San Paolo) first reached the aerials of the Red Sea and Indian Ocean stations.

As a consequence of the new facilities offered by radio-telegraphic connection with the Motherland, the traffic augmented rapidly at the Massawa station, and it was necessary, therefore, to erect a receiving duplex station at Asmara, the capital city of Erythrea. In this construction I followed the same systems employed with excellent results in other high-power Marconi stations, using a long directive Marconi aerial.

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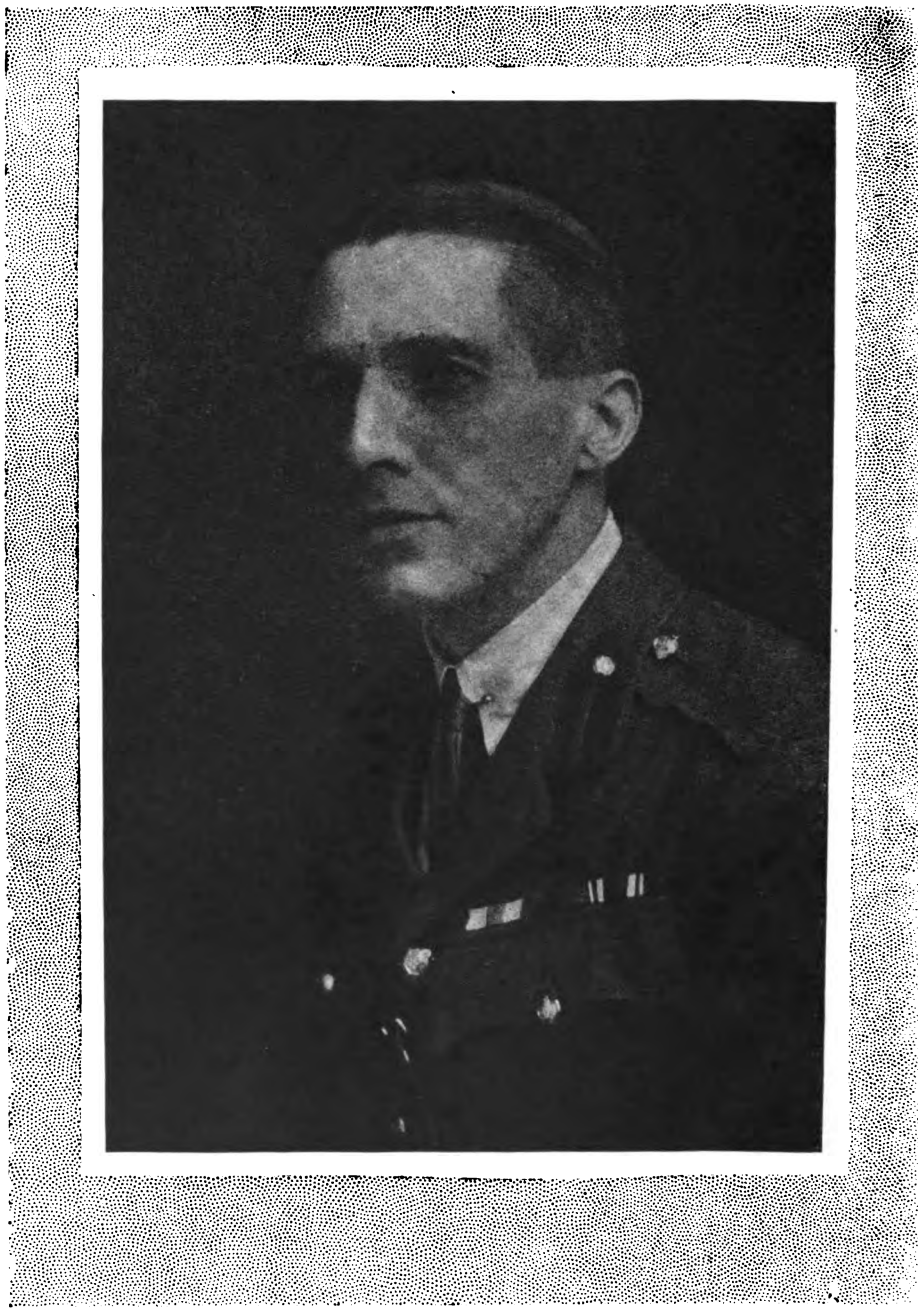

LIEUT.-COLONEL ADRIAN F. H. SIMPSON, C.M.G.

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Personalities in the Wireless World

LIEUT.-COLONEL ADRIAN F. H. SIMPSON, C.M.G., (late) R.E., was born in 1880, the son of Surgeon-General Sir Benjamin Simpson, K.C.I.E. Educated at Clifton College and the Royal Military College at Sandhurst, he entered the Army in 1900 and was gazetted to the 31st East Surrey Regiment, which was at the time stationed at Lucknow. In the following year he joined the Hyderabad Contingent of the Indian Staff Corps and served in the Bengal, Bombay, and Madras Residencies, afterwards obtaining command of a detachment of Native Troops in charge of one of the Prisoner Camps which had been formed in connection with the South African War. He also took up his share of "the white man's burden" by serving on plague duty in Central India.

In 1903 he proceeded to Russia and in 1906 succeeded in passing the Military examination for a Russian Interpretership. He also obtained Government awards for proficiency in Persian and Hindustani.

In 1907 he retired from the Army in order to devote himself to the study of Electrical Engineering and, in particular, Wireless Telegraphy. He was the Directeur Administrateur of the Société Russe des Télégraphes et Téléphones Sans Fils, Petrograd, and Director of the Telephone Construction Company of Moscow and the Moscow Electrotechnical Works.

Lieut.-Colonel Simpson is widely travelled and has visited at various times Cashmere, Finland, Scandinavia, and is well acquainted with India and Russia.

On the outbreak of war he at once rejoined the forces and was sent on a special mission to Russia. Here he served with the Caucasian Cavalry Division and was A.D.C. to the Grand Duke Michael Alexandrovich in the Galician Campaign of 1914-15. He transferred to the R.E. in 1915 and served on the general staff at the War Office in 1916. Lieut.-Colonel Simpson has recently been appointed Director of Wireless Telegraphy under the Government of India. His long and close connection with Wireless Telegraphy in England and various parts of the Continent, and with a number of firms such as the English De Forest Wireless Telegraph Syndicate, Ltd., the Amalgamated Radio Telegraph Co., Ltd. (owning the Poulsen Patents), the Lepel Wireless Telegraph Co., Ltd., Marconi's Wireless Telegraph Co., Ltd., and the Russian Company of Wireless Telegraphy and Telephony of which he was Managing Director, his wide experience of men and affairs, and his linguistic attainments all furnish guarantees that he will carry out his new duties with distinction.

He is a Chevalier of the Order of St. Anne, 3rd degree, and of the Order of St. Stanislas, 2nd degree with Crossed Swords, and an Associate Member of the Institution of Electrical Engineers.

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Notes on the Physics of the Thermionic Valve

By T. G. Petersen.

(Continued from February Number.)

Exhaustion Methods.

WHEN discussing Tungsten as an emitter for valve work it was remarked that "it is necessary (1) to attain an exceedingly high degree of vacuum and (2) to maintain such degree of vacuum" (Wireless World, Jan. 1920). The attainment of the low degree of pressure necessary in hard valves, was not, at one time, an easy matter. Although gauges on the pumping circuits indicated extremely low pressures, valves exhausted showed no consistency in their behaviour. Occasionally it was found possible to produce a valve in which the necessary vacuum had been attained, but which on running in a circuit as a radio device, rapidly showed signs of lowered vacuum. This lowering of vacuum frequently rendered such valves quite useless.

In the manufacture of the modern Tungsten filament lamp, for lighting purposes, satisfactory results may be obtained when a well-designed mechanical pump is used as the only means of evacuation. The degree of pressure in such lamps will often reach as low as 0·000001 mm. of mercury after a run of a few hundred hours, but it should be borne in mind that the nickel or other metal supports are never sufficiently hot to cause them to throw off vapours, the heat area being largely confined to the Tungsten filament itself. This high degree of vacuum is therefore due to absorption of gases by the filament, as already explained.

Pumps of various designs which had been used successfully in the manufacture of electric lamps completely failed to produce the high degrees of vacuo necessary in valves employing a pure electron discharge. Since the functioning of these pumps is, in the main, dependent upon the diffusion of gases from the vacuous space into the pump itself, a limit is reached when the diffusion outward is less than the back diffusion from the pump. Unless means are taken to prevent back diffusion there must always be a limit to the degree of vacuum obtainable with such a device.

For instance, in the Sprengel type of pump (Fig. 18) columns of mercury are caused to pass an aperture of the vessel which is to be exhausted of gases, and in doing so to carry with them the gases diffused into their path from this aperture. Apart from the inherent limitations of such a pump mercury vapour is liable to diffuse back into the vessel under treatment, at a quicker rate than

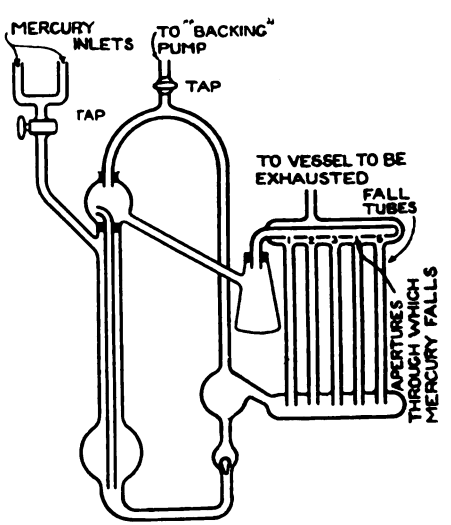

Fig. 18.

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the gases diffuse outwards. In addition, this pump is extremely slow in operation and much auxiliary gear is required.

The Gaede mercury diffusion pump, although of greater speed, and capable of giving higher degrees of vacuo, has yet an inherent weak point which makes it unsuitable for use in evacuating valves. Instead of a continual succession of small columns of mercury, a blast of mercury vapour is caused to pass the aperture of the vessel. The width of the aperture, however, is accurately calculated from Gaede's theory that the maximum speed of the pump is reached when the aperture width is equal to the mean free path of the gases tending to diffuse back into the vacuous space. Whilst the blast of mercury vapour is very effective in carrying away the outward diffused gases (*i.e.*, those leaving the vessel to be exhausted), the vapour atoms will not all necessarily have vertical velocity components, but some will be moving towards the walls of the pump, and on striking that comparatively cold surface will condense. The heat thus generated will, however, be sufficient to cause some of them to re-evaporate as quickly as they condense. On becoming free once more they are just as likely to diffuse out through the aperture against those gases leaving the vacuous vessel. An attempt has been made to show this in Fig. 19.

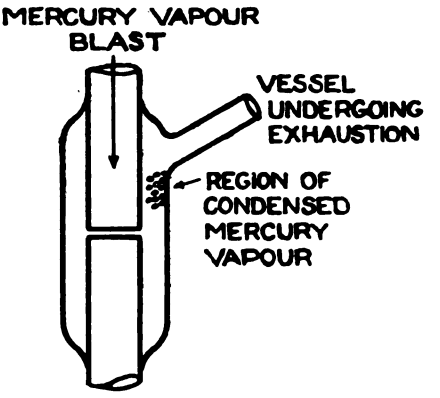

Fig. 19.

The Langmuir Condensation Pump.*

In designing his condensation pump Langmuir was aware of this limitation, and sought to remove it by the careful design of the flare of the vapour blast funnel, and the dimensions of the aperture, but mainly by cooling at the desired points. The universal usage, at the present time, in respect of pumps embodying the water-cooling device as suggested by Langmuir, is sufficient evidence that he has been highly successful in his efforts at eliminating the defects of the mercury vapour pump as investigated by Gaede. Some idea of the operation of this pump will be grasped from the following. In Fig. 20 are depicted a Langmuir Condensation Pump, the liquid-air trap and a transmitting valve, with the voltage sources for filament and anode. The mercury at the base of the pump is heated externally, with the result that a blast of vapour is forced up towards the deflector D. Owing to the flare of the funnel the blast increases in intensity in its upward motion. On hitting the deflector the blast is sent downwards, and outwards against the water-cooled sides of the pump. Owing to the curvature of the deflector the majority of mercury vapour atoms will travel downwards, carrying with them the gases diffusing from the valve. Those atoms which have a transverse direction of movement will condense, and since the sides are water-cooled, re-evaporation will not take place, but the condensed mercury will return to the reservoir at the bottom of the pump. In this respect the condensation pump is much superior to the Gaede diffusion pump, in which, as has already been explained, re-evaporation does take place, with the consequent back diffusion and the limitation in degree of vacuum obtainable.

The gas brought down by the vertical blast will now be carried off by the backing pump working at A. The vapour blast increases in intensity as it nears the bottom and, owing to the constriction at this point, is caused to come under the influence of the con-

* "Physical Review," July, 1916.

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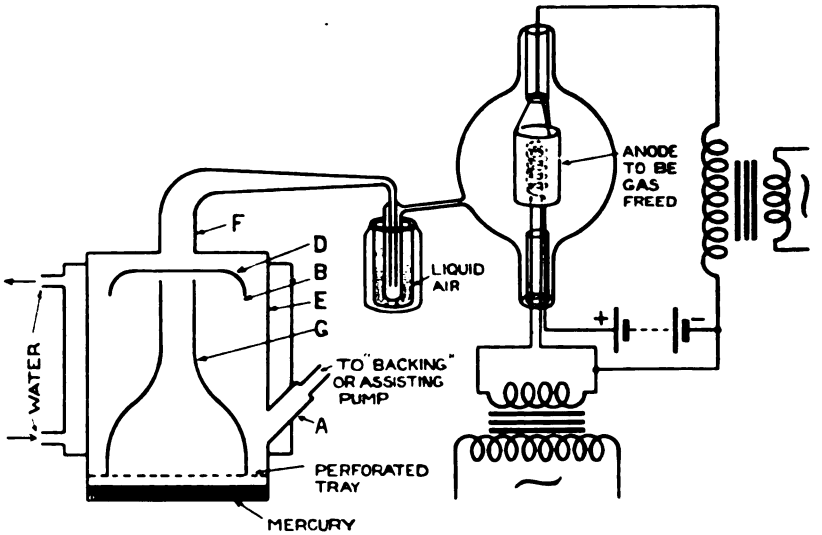

Fig. 20.

denser and thus falls back into the reservoir, ready for further cycles of evaporation and condensation.

There is, therefore, no theoretical lower limit to which this pump can exhaust, as the flow of diffused gas into the pump from the vacuous vessel is always greater than that tending to diffuse back. Pressures as low as 10^{-5} bar (1 bar = approximately one-thousandth of a millimetre of mercury pressure) have been obtained by means of this form of pump; the measurement was, however, recorded on a gauge of special design introduced by A. W. Hull.

The McLeod Gauge.

Gauges reading as low as 10^{-5} bar are not, however, absolutely necessary in practice, the McLeod gauge being robust and quite adequate to indicate the degree of vacuum at which gas-freeing of the electrodes may be commenced.

A simplified diagram of a McLeod gauge is shown in Fig. 21. When it is desired to ascertain the pressure arrived at during pumping, the movable reservoir of mercury is lifted up, thus forcing the mercury up both C and B. The level in C will be higher than that in B, since the gases in the former are practically unconfined, whereas those in B are compressed by reason of the tube's sealed end. The difference of these heights is a measure of the pressure in C. The volume of the gases in B is measured by the graduations along it. The total volume of A and the tube B above the point of junction with C is also known. If this

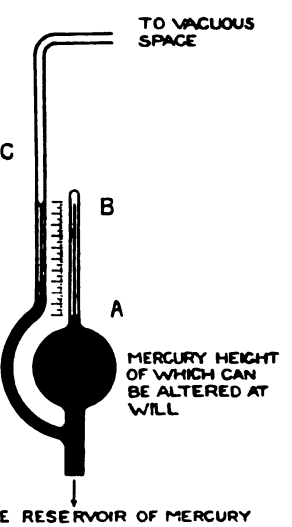

Fig. 21.

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volume be represented by V, the volume of the gas confined in B by v, and the pressure indicated by the difference in level of C and B by P, then the pressure in millimetres of mercury, of the vacuous space to be measured is given by

$$\rho = \frac{Pv}{V}$$

In practice such a calculation is not made, but a scale is attached from which a rough indication may be obtained, or the pressure is read directly in millimetres of mercury.

Liquid Air.

Returning to the consideration of Fig. 20 it will be noticed that between the valve and the condensation pump a liquid-air trap intervenes. In this trap any mercury vapour that may have diffused back from the pump will be brought to such a low temperature as to make the pressure due to its presence a negligible quantity. For instance, if it be supposed that the inner surface of the trap has a temperature of $-180°$ C (the temperature at which liquid air commences to boil) then the pressure due to the mercury will be $2{\cdot}3 \times 10^{-27}$ millimetres of mercury, a negligible quantity.

The use of liquid air is very necessary, for, if the temperature be not lower than, say, $-40°$ C, although mercury freezes at this point the pressure it exerts is equivalent to ·0000023 millimetres of mercury, which may not be a value to be ignored.

Electronic Bombardment as a Gas-freeing Process.

It will be noted that in Fig. 20 there are shown means of heating the filament and of maintaining the anode at a high potential with respect to the filament. Although great care be taken to render gas-free the units comprising the electrodes and their supports before inserting them in the bulb, much remains to be done by reason of imperfect gas-freeing in the first place, and the absorption of gases by these components during the time after gas-freeing and before evacuation. The method employed to effect final elimination of gases from the metal parts is that of electronic bombardment.

In practice the anode is maintained at a high potential with respect to the filament throughout the process of exhaustion. This may be done either by means of an alternating or a direct voltage. Of the two the latter is more desirable and is easily obtained by using a high voltage transformer in conjunction with valve rectifiers, in which case it is necessary to connect the rectifier in one leg of the transformer secondary in such a way that one side of its filament is connected to the anode of the valve to be exhausted, thus maintaining this electrode at a high positive potential.

As will be obvious later, it is imperative that the filament of the valve to be pumped be kept dull. In the event of the high voltage available being insufficient, the bombardment may be assisted by the application of a positive potential on the grid, as shown in the figure.

When the McLeod gauge indicates a sufficiently high degree of vacuum, the filaments are brightened up and a blue fluorescence is produced throughout the bulb and down the circuit tubes. Simultaneously the anode becomes reddened, although this may not be apparent until the filament is dulled again. The process of alternately brightening and dulling the filament, with periods for cooling the anode, is employed until little or no fluorescence results.

This phenomenon of electronic bombardment, which manifests itself by the blue glow and by the reddening of the anode, puts a severe strain on the filament. During the periods in which the filament is dull the number of electrons hitting the anode is insufficient, in spite of their velocity, to heat it up to any appreciable extent. When, however, the emission is increased sufficiently, heat is produced on the plate by the bombardment of its surface by

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the stream of cathode rays caused by the strong electric field. Provided the heat produced is great enough, gases occluded in the electrode (*i.e.*, held within the metal or on its surface) will be released and drawn away by the continuous action of the pump. Some of the gases come within the path of the cathode rays from the filament and are in consequence split up or ionized. An immediate result is the release of additional electrons and the formation of positive ions of molecular dimensions. These additional electrons then assist in the bombardment of the anode, whilst the positive ions, attracted by the high negative potential, bombard the filament.

Now the filament is already at a considerable temperature (approaching that of its melting point), and coupled with the fact that it is fragile, the bombardment is very liable to disintegrate it, if allowed to become excessive.

In practice great care is required in this process, for much previous good workmanship may be spoilt by an unnecessarily long or too severe a period of bombardment.

It has been stated that it is imperative to keep the filament dull throughout the early stages of exhaustion. It will be obvious that if the bombardment is commenced when too much gas remains, the positive bombardment of the filament will be so great as to completely destroy that electrode.

If it ever becomes possible to produce the original emission by other than thermal means, such as photo-electric methods, the cathode might be robust enough to withstand this bombardment. The stage will then have been reached when much higher anode voltages may be safely used.

Minor Exhaustion Details.

In the case of small receiving valves it is possible to arrange that a number may be simultaneously gas-freed by the process outlined. This method considerably reduces the total time of exhaustion. With this type of valve difficulties are encountered during bombardment because of the close proximity of the electrodes, the static pull caused by the high potential on the plate frequently being sufficient to bow the filament to such a degree as to force it into contact with the grid. Assuming that the grid had been previously connected to the filament externally (*i.e.* it had zero difference of potential with respect to it), the screening effect now becomes entirely destroyed, and in consequence an excessive current flows through the valve—with disastrous results.

The total period of exhaustion, in spite of a lengthy bombardment does not in the case of small receiving valves usually exceed two hours. Further, as many as twelve valves may be exhausted simultaneously, so that this brings down the length of time for each valve to be exhausted, to ten minutes.

The larger variety have usually to be exhausted singly or, at the most, in pairs, and take from 3 to 5 hours in the exhaustion operation, even when a rapid pump is used.

Ionization in Valves during Use as Radio Devices.

The process of gas-elimination from the metal parts can, however, never be absolutely complete, and that this is so becomes apparent during the operation of the valve as a radio device. Especially is this true with respect to transmitters, where large electronic currents are present. If, however, keying arrangements are made which break and make these large currents, the danger of ionization is greatly lessened, since the spaces of time intervening between and in the Morse characters, are adequate to preventing undue accumulation of heat on the anode.

When such interruption is not practicable the anode may attain a temperature sufficient to release a little gas, in which case ionization by collision will take place, and if the valve is not immediately cooled (by dulling the filament or otherwise decreasing the flow of electronic current), the vacuum may be brought so low and the filament disintegrated so badly, as to render the valve of no further use.

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Digest of Wireless Literature

ZWEI MIT HILFE DER NEUEN VERSTÄRKER ENTDECKTE ERSHEINUNGEN.

By H. Barkhausen.

Physikalische Zeitschrift, Sept. 1919.

(1) Noises from the Demagnetisation of Iron.

With the recently developed vacuum tube amplifiers it is easily possible to obtain a current amplification of 10,000 which is equivalent to an energy amplification of 100,000,000. By means of these instruments small changes in electric or magnetic fields which would otherwise escape our notice can be made perceptible. One can regard their help as being that of a new type of electrical microscope which magnifies things ten thousand times. Quite recently Scholtky has shown that, by using enormous amplification the electrons of a vacuum tube can be heard in their flight as the current executes spontaneous variations in accordance with the laws of the kinetic theory of gases.

A similar phenomenon has been discovered by the writer and Herr Dr. Tuczek in the case of iron. It has been found that iron produces a "noise" on being demagnetised. When the magneto-motive force is altered the molecular magnets settle down rapidly in their new positions and in so doing generate in a surrounding coil irregular electrical impulses which can be heard as a noise in the telephone. Fig. 1 shows the simple experimental arrangement employed. The iron core E is surrounded by a coil S of 25 mm. diameter and 300 turns. The ends of the coil are connected to a telephone through an amplifier. By moving the horse-shoe magnet M and so altering the induction the noises in the telephone can be produced.

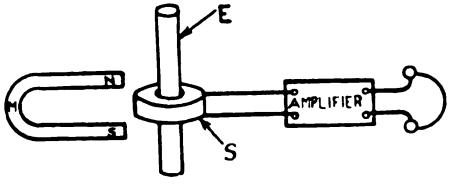

Fig. 1.

It has been found that the thicker the iron core the weaker is the noise produced. For example a core 20mm. thick gives no sound at all. From a great number of experiments it has also been found that the softer the iron the greater is the intensity of the noise. Hard steel gives hardly any effect while the noise with soft iron is particularly marked. It is desirable that many further and more detailed experiments should be performed on this subject as it seems probable that there is some connection between this phenomenon and the action of the Marconi magnetic detector.

(2) Musical Sounds from the Earth.

During the war amplifiers were used on both sides of the front for the interception of enemy telephone messages. The telephone currents were detected partly by electromagnetic induction and partly by means of the stray earth currents which escaped from the telephone wires at points of defective insulation. Although these currents are extremely feeble the enormous ampification available could be utilised to make them audible. The listening circuit normally used is shown in Fig. 2. The two earth electrodes A and B which are usually 100 metres apart are led through an amplifier to the telephone

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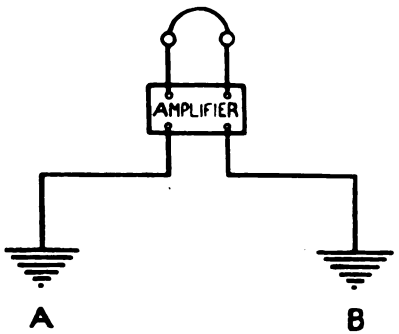

Fig. 2.

T. With such a circuit a most remarkable piping note is heard at times. At the front operators usually refer to these noises as "flying grenades." It is difficult to imitate the sound by a word but the spoken word "piou" gives a slight idea of what is heard. Physically the note appears to be that due to an oscillation of practically constant amplitude but of quickly varying frequency, the frequency at the beginning of the sound being the highest audible and dropping rapidly to the deepest audible tones. On account of the properties of the amplifier (design of telephone, etc.), the note is particularly strong when the frequency is 1,000. The whole phenomenon lasts about a second.

On many days these earth sounds were so strong and numerous that ordinary interception could not be carried on at the same time. The phenomenon seems to be correlated with atmospheric conditions and was particularly noticeable on the mornings of the warmer days of May and June. It differed completely from the normal atmospheric strays which produce only crackling or bubbling noises in the telephones.

The earth electrodes which are the origin of occasional noises can scarcely be regarded as the source of these sounds; neither is it probable that the effect is due to some meteorological influence on the deeply buried earth wires. Much more likely is the suggestion that the amplifier itself, energised by a particularly strong atmospheric generates these oscillations. But all experiments tried in the laboratory to imitate this phenomenon have so far failed. Various types of electrical impulses and spark flashes have been tried but with no result. Thus no complete theory can be advanced for the cause of these weak alternating currents which originate so freely in the earth.

THE RADIO RESEARCH BOARD.

The Department of Scientific and Industrial Research has appointed a Radio Research Board to co-ordinate and develop researches in wireless telegraphy and telephony, which are at present being prosecuted by Government departments. The Board is composed as follows:—Chairman, Admiral of the Fleet, Sir Henry B. Jackson, G.C.B., K.C.V.O., F.R.S.; Comdr. J. S. Salmond, R.N. (representing the Admiralty); Lt.-Col. A. G. T. Cusins, C.M.G. (War Office); Wing Commander A. D. Warrington Morris, C.M.G., O.B.E. (Air Ministry); Mr. E. H. Shaughnessy, O.B.E (Post Office), Prof. J. E. Petavel, F.R.S., and Prof. Sir E. Rutherford, F.R.S.

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Stray Waves

THE AMATEUR POSITION.

SO far as the progress of the Amateur Club movement is concerned matters improve steadily month by month. We have received news of the formation of several new clubs, shoals of enquiries as to where clubs exist, and a number of letters intimating the writers' willingness to start clubs. We are gratified, too, to note that the scheme to form an affiliation of the provincial clubs with the Wireless Society of London is meeting with great success. Under Wireless Club Notes will be found the definite proposals formulated by the last-named Society.

Professor E. W. Marchant, D.Sc., in his address as Chairman of the Liverpool Sub-centre of the I.E.E. on January 19th, said: " ..... of all the branches of this problem the one which Liverpool people must fully appreciate is Wireless Telegraphy." " Liverpool is a centre which lends itself particularly well to the study of wireless problems, and it is hoped that the activities of research in this direction will be considerable." Now the Liverpool Wireless Association is trying to resume its activities, and we hope Liverpool amateurs will rally round the Secretary, Mr. S. Frith, 6, Cambridge Road, Crossley, and assist him to make the Association worthy of Liverpool.

* * *

WIRELESS SIMPLIFIED.

An article entitled " Wireless and the Press," which appeared in *The Newspaper World* of January 3rd, describes what appears to be the last word in wireless receivers and X-stoppers. After stating the times at which news is transmitted by certain stations, the article proceeds to explain that: "Contact is established with these stations at the above hours by bringing a switch into contact with a metal stud representing the wavelength of the particular station, whilst the rotation of a knob eliminates undesirable noises."

* * *

MESSAGES FROM MARS.

When the pure journalism is separated from certain recent articles in the daily press the fact emerges that Senatore Marconi is about to prosecute some researches in wireless phenomena which are observable on wavelengths of the order of hundreds of miles. Apparently signals have been heard on wavelengths much greater than any employed by known stations, and are deemed to merit investigation. The signals may be mere *x*'s, or they may represent deliberate attempts at signalling from another planet. In the present state of our knowledge one is at a loss to express an opinion on this question, especially as it brings up others, such as whether intelligent beings exist on Mars, and whether their intelligence has developed along the same lines as our own.

The following letter from Mr. Marconi appears in the *Electrician* of Jan. 30th:—

Sir,—I desire to protest against the interpretation that appears to have been put upon statements which I have made at intervals during the last few years with regard to the possible sources of what are being termed " mysterious messages from the unknown." Wireless messages are transmitted through the ether by the agency of electromagnetic waves of definite lengths which can be ad-

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justed, and in order to receive such messages the receivers should be tuned to the particular wavelength that is being used for transmission.

At times signals are received which are apparently due to electromagnetic waves of great length (up to hundreds of miles), and these signals are not of the same character as those commonly called "X's" or "strays." Occasionally such signals can be imagined to correspond to the Morse signals for certain letters, and these signals occur at all seasons and irregularly.

The sources of such signals are unknown. They may be in the atmosphere or outside it, and due to electrical disturbances. If outside the atmosphere, they may arise in any point of interplanetary space, possibly in the sun, where it is well known that electrical disturbances occur.

Obviously, since the planet Mars is situated somewhere near in interplanetary space, the source of such signals might be on it or on any other planet. There is NOTHING, however, to show that this is the case, nor must any purely fanciful speculations of mine be interpreted to mean that I have asserted having received any intelligible or unintelligible messages from Mars or from any other point in space outside the earth.

I am, etc.,

G. MARCONI.

London, Jan. 28th.

* * *

THE EFFECT OF GASES ON THE EMISSION OF ELECTRONS FROM HEATED FILAMENTS.

La Nature of January 10th last contains an interesting article which deals incidentally with the intimate relation between the electronic emission from heated filaments and the chemical activity of the filament.

The writer states that the emission of electrons from a filament is generally lowered by the formation on the filament of a layer of gas when traces of the particular gas are present.

He proceeds to say that experience shows that with tungsten in all cases where it has been employed with a chemically inert gas, the emission of electrons by the heated filament was not modified or choked, whilst in cases of gases which combine with tungsten this emission was diminished, and that it is reasonable to conclude from this that this action is due to the gaseous layer on the filament. According to the writer of the article, the layers have a thickness of one molecule, rarely of two or more.

In *Archiv für Elektrotechnik*. July 24, 1919, M. Abraham deals in an interesting manner with the effect on radiation of compound antennæ. Two aerials, erected in close proximity, radiating synchronously, and having their capacity to earth mainly concentrated in the horizontal portions, will require an amount of energy to maintain them in oscillation greater than the sum of the amounts required for each individually, as each aerial will induce currents in the other. This increase of energy results in increased radiation, through the superposition of the two fields, but it vanishes when the oscillations of the two aerials are displaced in phase by a quarter of a period.

The interaction between the aerials affects, of course, the radiation resistance of each and also the frequencies of the respective antenna currents.

By using, at a given distance, a secondary aerial, excited only by the influence of the main transmitting aerial (and tuned to the same frequency) a complete shadow is thrown by the former and the radiation is at the same time increased in the opposite direction by a kind of mirror action.

A secondary antenna may also be used in a receiving station to screen the main antenna from certain radiations.

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The New Marconi Distress Calling Device

THE readers of the WIRELESS WORLD will have seen in various newspapers an account of a demonstration conducted between Chelmsford and Shelford (Cambridge), in which the station at Shelford rang an ordinary electric bell and exploded small mines at Chelmsford, by means of special wireless signals.

Some ships carry only one operator and he cannot spend anything like twenty-four hours per diem "listening in" on the offchance of hearing a distress call, and if such a call is made during his "watch below" it goes unheard by his ship.

To amend this state of affairs, and to make certain that distress calls would not pass unheeded, a little while ago the Research Laboratory of Marconi's Wireless Telegraph Company was instructed to carry out certain experiments on distant control. It was desired to be able to ring a bell at a distance by means of Wireless Telegraphy, and the object underlying the investigation was to contribute to the greater safety of life at sea.

The predetermined signal is a series of dots regularly transmitted at the rate of 180 per minute. This number was chosen as being not too fast for the operator to count and time, and as too slow to be interfered with by ordinary transmissions.

The first thing was to make a relay which would respond only to the predetermined signal, and which could be operated by the change in current produced by the reception of such a signal. The change in current with the valves in use in the receiver was never more than half a milliampere.

Many relays were made, and tried out, and for various reasons were rejected. The final design is as shown in Fig. 1, and in construction is not unlike the ordinary moving needle galvanometer. In brief the description is as follows:—Two rectangular hollow formers each wound with many hundreds of turns of very fine wire are placed one above the other on a brass base, the windings being connected in series, and the free ends being taken to two insulated terminals in the base. In the rectangular orifice of the coils swings a small ring magnet, pivoted at its centre and supported in jewelled bearings which are carried by two vertical brass pillars screwed to the base. The pivot also carries a small circular phos-

Fig. 1.

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phor-bronze spring, one end of which is attached to a brass collet on the pivot, the other end being soldered to a tongued brass washer clamped to one of the brass pillars. This tongued washer serves the same purpose as the zero adjustment on an indicating instrument. By twisting it about its centre the position of the magnet can be altered and the best working position obtained. Besides these two details the pivot has fixed at right angles to itself a fine platinum-tipped steel arm. This arm is one pole of a switch and is connected by way of the brass pillar, spring, and pivot, to the base of the instrument. The other pole of the switch is a small piece of hard carbon, fixed to one end of a strip of flexible copper, the other end of which is supported on a small pillar and connected to a terminal insulated from the base. A glass front is provided in the case of the instrument, so that the action can be inspected from without, and the whole case screws down on to the brass base, rendering the interior dust-proof. Two gauze-capped leaden tubes containing a drying agent will be seen in Fig. 1. The whole instrument is swung in gimbals.

By adjusting the length of the phosphor-bronze spring it is possible to arrange that the wheel magnet, pivot, and arm oscillate at the rate of 180 complete periods per minute.

The resistance of the coils and the current available are sufficient to prevent a single dash, or series of mixed dots and dashes, such as are received in an ordinary telegraphic communication from swinging the moving system far enough to cause the two contacts of the tiny switch to touch. It is only by the regularly-delivered impulses arriving at the right moment that the swing can be built up from zero to full, and contact established.

Some trouble was experienced with this tiny switch. In the original model both contacts were made of platinum and sometimes they did not strike with sufficient force to make good contact at the first time. To overcome this fault Dr. Fleming's Patent No. 112544 of 1918 was employed. The modified connections of this patent are as shown in Fig. 2. In Fig. 2, Pt is a contact of platinum

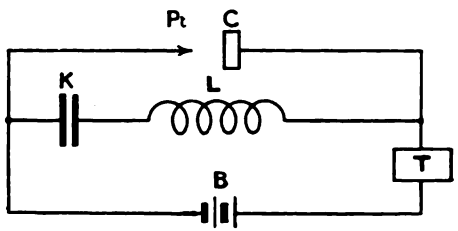

Fig. 2.

or other noble metal, C is a hard carbon contact, K a condenser, L an inductance, T an instrument which it is desired to operate by the battery B on closing the switch Pt. C. The battery charges the condenser, and when the switch closes the condenser discharges through the inductance and oscillations pass across the points Pt C and improves the contact at those points.

The point next to be considered was an arrangement for permanently closing the alarm circuit once the contact had been struck, and the instrument shown in Fig. 3 was designed.

This instrument consists of two coils with soft iron cores mounted on a soft iron plate, forming an electromagnet.

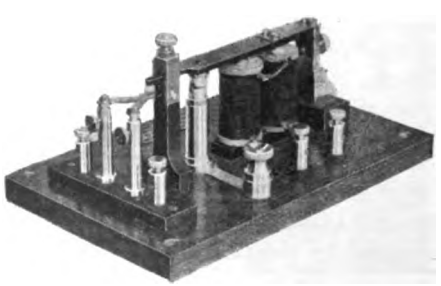

Fig. 3.

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Above these coils is placed a soft iron armature connected with a flat steel spring at one end to a brass standard, the other end being free. At the free end is carried a small insulator, which, when the electromagnet is energised, will depress a short platinum-tipped steel spring on to a similar one; also at a little distance from the free end is fixed a manipulating key contact which can strike a similar one situated immediately beneath it.

The action is as follows:—The platinum-carbon switch of the receiving relay, is connected in series with a twenty-four volt battery and the coils of this electromagnet; the two platinum-tipped steel springs are connected in parallel with the platinum-carbon switch. When this switch makes contact the electromagnet is energised and the armature is drawn down and closes the switch formed by the two steel springs. This switch being closed and in parallel with the first switch the magnet will remain energised, and the armature depressed, until the battery is switched off. Fig. 4 shows these connections. Neglecting the resistance of the connections, it will be seen that as long as the electromagnet is energised there will be a P.D. of about twenty-four volts at its terminals. The alarm bell, which is an ordinary high-power bell working off twenty-four volts is connected in parallel with the electro-magnet, and so long as the latter is energised the bell will ring.

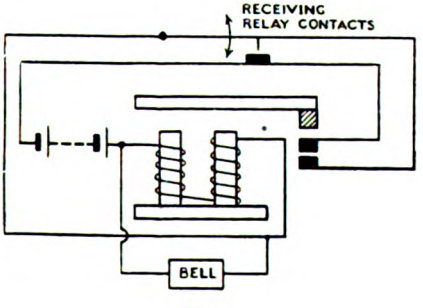

Fig. 4.

The adopted automatic transmitter is as shown in Fig. 5. The instrument consists of two iron-cored coils mounted on a yoke, the whole forming an electromagnet. Between the poles of this magnet swings a heavy brass ring with a soft iron diametric bar. To the shaft carrying the ring are attached a spiral steel spring, like a clock spring, and a light flexible steel arm tipped with platinum. Below this arm is a small platinum contact, supported by a helical spring contained in a tube. The free end of the

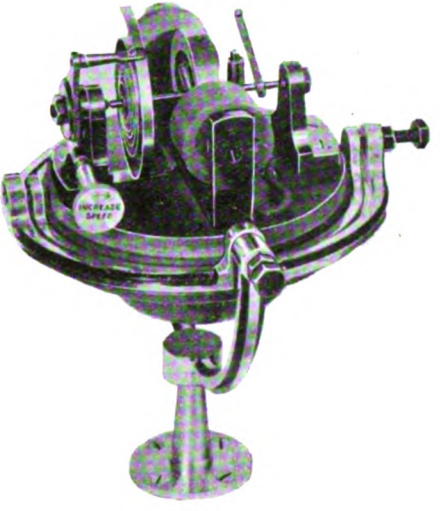

Fig. 5.

clock spring is clamped to a projection on the wheel of a worm gear, and a handle is provided on the screw of this gear, so that the distance of travel between the moving contact on the shaft, and the spring-supported contact, can be varied. The variation of this travel controls the period of the transmitter, and it is found that the shorter the travel the shorter the period. Three terminals are brought through the base and the whole instrument is mounted in gimbals.

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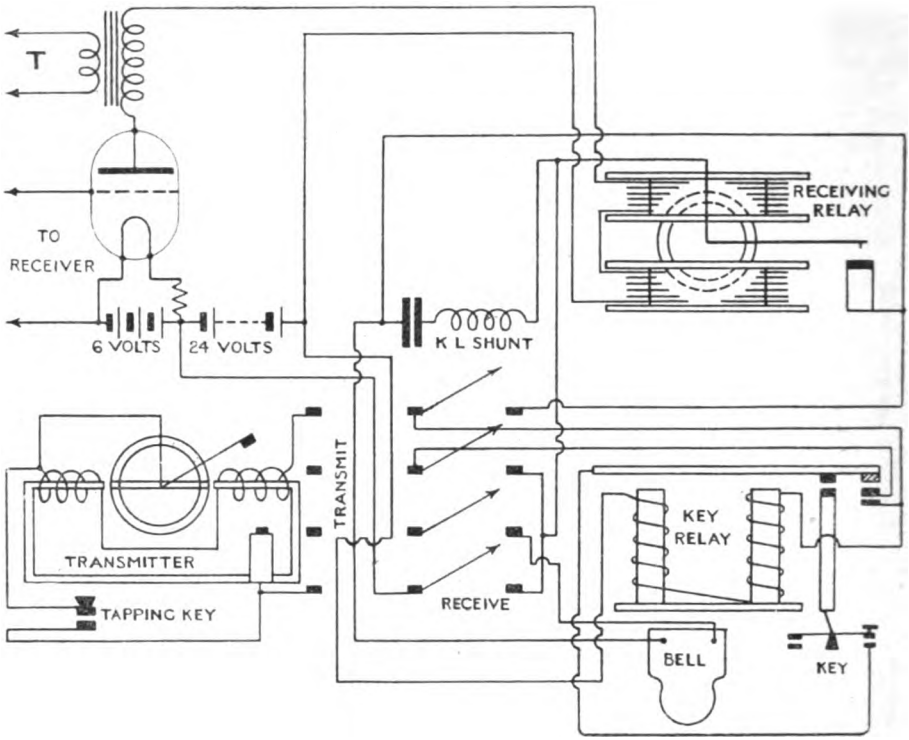

Fig. 6.

For transmission a series circuit is made comprising a twenty-four volt battery, the coils and contacts of the transmitter, and the coils of the instrument shown in Fig. 3; a small tapping key is connected in parallel with the transmitter contacts. To start the instrument this key is pressed and immediately released. By thus closing the circuit the electromagnets of both instruments are energised and the iron bar of the wheel swings towards the magnet. The circuit being broken and the magnet demagnetised the wheel is urged by the clock spring past its position of rest, and on until the contacts of the transmitter touch; attraction starts again and the circuit is again broken, and so the cycle of events is repeated as long as the battery is switched on. Each time the wheel transmitter is energised the electromagnet shown in Fig. 3 is energised, the armature is drawn down, and the heavy key contacts meet. These contacts are in parallel with those of the manipulating key of the ship set, so provided that the generator is running, sparking occurs at every striking of the contacts. By means of a watch and the worm gear previously referred to, the operator can adjust the frequency of his signal to a nicety, and when once this is adjusted it is unlikely to vary.

Fig. 6 shows the complete diagram of connections from the last valve of the receiver to the contacts of the manipulating key.

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How to make a Telephone Transformer

By A. D. KENT.

Here, at last, is the article for which so many amateurs have asked.

IT is a common practice when using a crystal as a detector to employ telephones having a resistance of the order of 3,000ω to 4,000ω each. The reason of this is, that in order to increase to a maximum the magnetomotive force of the telephone field coils, the latter are wound with as many turns of wire as is possible. Therefore, the finest copper wire is used. This means that the telephones will have a very high resistance—about 8,000ω; this does not matter very much, however, considering that the resistance of the crystal at its most sensitive point is about 10,000ω. It is therefore obviously inefficient to use low resistance telephones of about 150ω in a circuit which already has a resistance of at least 10,000ω.

For the benefit of amateurs who only possess low resistance telephones and to whom the purchase of high resistance telephones is a big item, and also of amateurs who are in doubt as to which to buy—high or low resistance telephones,—I intend to describe the simple construction of a telephone transformer —the use of which in conjunction with low resistance telephones will give results equivalent to those obtained with high resistance telephones.

Apart from any other considerations, the use of a telephone transformer in a valve receiver circuit is most essential, for the telephones are then well insulated from all the other circuits. Amateurs who possess valve receivers will doubtless have experienced the troubles caused through bad insulation in their telephones.

CONSTRUCTION OF TELEPHONE TRANSFORMER.

To commence building the transformer the following materials will be required:—6 ozs. No. 30 single silk covered copper wire, 3 ozs. No. 44 single silk covered copper wire, 6 ozs. No. 24 soft iron wire, bare, 2 pieces of hard wood, $2\frac{1}{2}'' \times 2'' \times \frac{3}{8}''$, 4 brass terminals and nuts, insulating tape, waxed paper, paraffin wax and 12″ of rubber valve tubing.

To build up the core, cut the iron wire up into sufficient 3″ lengths to make up a circular iron core $\frac{3}{4}''$ in diameter, which must be firmly bound with insulating tape. The tape will serve the double purpose of securing the wire and insulating the secondary winding from the core.

The two pieces of wood we will use as the two flanges or cheeks of the bobbin, and to mount the terminals upon.

Fig. 1 shows quite clearly the method of mounting and fixing the core into the wood, preparatory to winding. The No. 30, or thick winding, we will call the secondary and will wind it direct on to the iron core which we have insulated. Proceed as follows:—Drill a small hole in the wood cheek just above the core, large enough to allow the wire with a few inches of valve rubber on it to go through. This wire can be secured to one terminal, but before proceeding to wind bind the first turn on to the core

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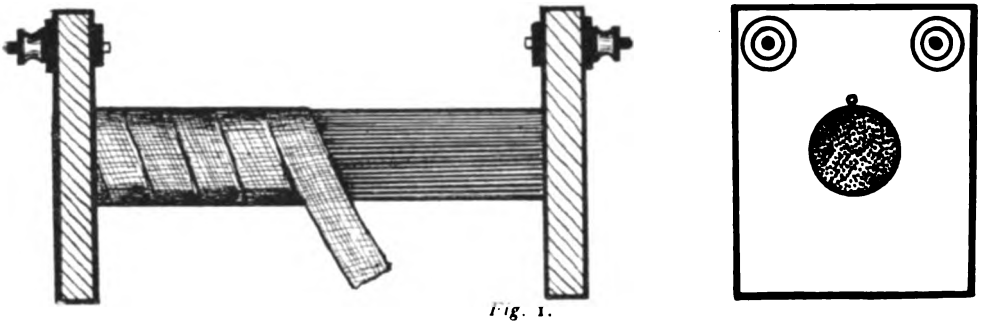
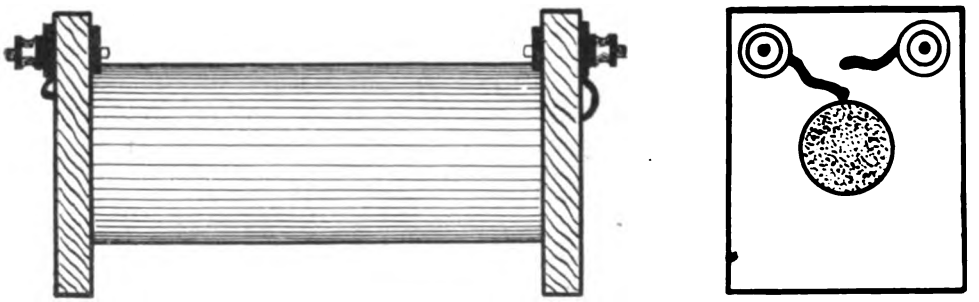


Fig. 1.

with cotton in order to take the strain off the wire connections. Winding can now proceed, care being taken to wind evenly and not to damage the insulation of the wire as it is guided through the fingers. It will be found easiest to wind over the bobbin, *i.e.*, turn the transformer bobbin clockwise, feeding the wire through finger and thumb, the reel of wire being mounted on a spindle and free to turn, not too easily, between yourself and the transformer bobbin.

face upon which to commence winding again. Proceed to wind as in the case of the secondary, taking every precaution to protect the insulation of the wire during the process, as with these fine wires the insulation is easily rubbed off. Fasten the two ends of the wires to the remaining two terminals and mark them P.

The transformer now being complete, heat up some paraffin wax until it is just liquid. Immerse the transformer in it and leave it for half an hour, keeping the



The completed Tranformer.

When the end of the layer is reached commence another layer winding from right to left and so on, always winding in the same direction until the 6 ozs. of wire are used up. The last turn should be tied off with cotton and the end, insulated with rubber tube, should be brought through the wood cheek and secured to a terminal.

The two terminals should now be marked S. Before winding the primary wire on, wrap a few turns of waxed paper, not more than three, round the secondary. This will serve as insulation and also to give a fresh even surface upon which to commence winding again. Proceed to wind as in the case of the secondary, taking every precaution to protect the insulation of the wire during the process, as with these fine wires the insulation is easily rubbed off. Fasten the two ends of the wires to the remaining two terminals and mark them P.

The transformer now being complete, heat up some paraffin wax until it is just liquid. Immerse the transformer in it and leave it for half an hour, keeping the wax just liquid. If the transformer is taken out at the end of this period and left to drain, all the superfluous wax will drain out, although the windings will retain sufficient to protect the insulation from damp. To finish the transformer off neatly, wrap several layers of waxed paper round the primary and wrap one layer of bookbinder's cloth over all to complete. The resistance of the windings should be approximately :—Primary, 4,500ω; secondary, 60ω. The primary should be connected in the crystal circuit of the receiver, and the secondary connected direct to the telephones.

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Notes on the Design and Construction of Valve Amplifiers

By John Scott-Taggart.

IV.—RESISTANCE AMPLIFIERS.

THE third general class of amplifiers embraces those in which the coupling between successive valves is obtained by means of non-inductive resistances. This class of receiver has been previously described by the Author*, but some additional remarks here will not be out of place.

A simple two-valve circuit employing a resistance coupling is shown in Fig. 15. Incoming oscillations vary the potential of the grid G_1 whose normal value is made slightly negative by means of the potentiometer B_2. This will help to ensure that the first vacuum tube will act purely as an amplifier of the oscillations. A resistance R_3, which should be devoid of capacity or inductance is connected in the plate-circuit of the first tube. This resistance should be of the order of about 80,000 ohms when valves of the French or "R" type are used. The resistance R_3 is usually made more or less equal to the resistance of the valve across filament and plate. The resistance may be made by using suitable high resistance material, making connection to a strip of paper over

*J. Scott-Taggart. "The use of Impedance Capacity and Resistance Couplings in High-Frequency Amplifiers," Wireless World, February, 1919.

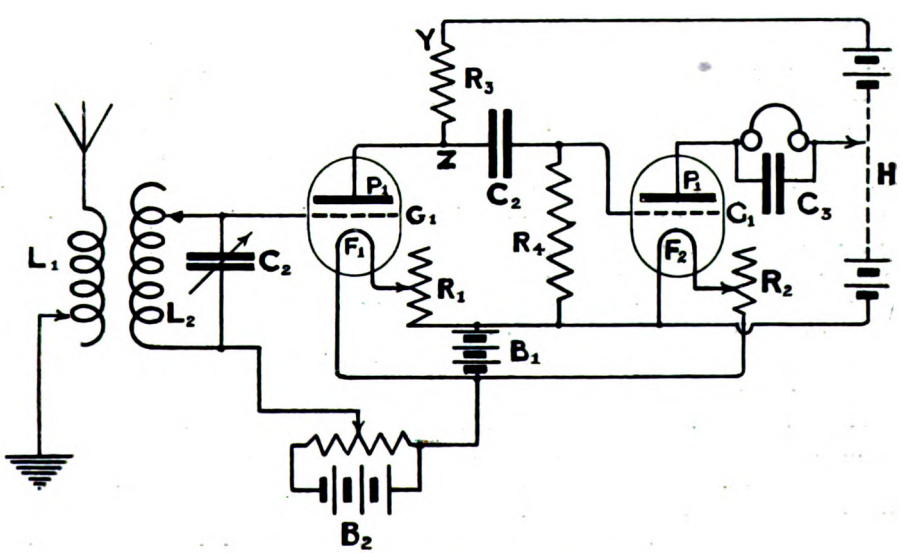

Fig. 15. Two-valve Resistance Amplifier.

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which a pencil has been rubbed, or by other suitable means. Such resistances, however, do not usually give as good results as the commercial article.

An electron current will normally flow from the filament F_1 to the plate P_1, through R_3 *via* the plate battery H, back to the filament F_1 which is heated through a rheostat R_1 by preferably a six-volt accumulator B_1 which also heats the filament of the second vacuum tube.

Since an electron current is flowing through R_3 from Z to Y, it will be clear that Z will be negative with respect to Y. Since the resistance R_3 is high, there will be a considerable voltage drop across it. Consequently, we need a higher voltage plate battery H than in ordinary valve circuits. From 80 volts to 150 volts is suitable.

To explain the action of the resistance amplifier, let us consider that with a plate battery H of 100 volts, the current in the P_1 plate circuit is 0·5 milliampere. The resistance of the plate circuit is consequently 100 divided by 0·0005 which equals 200,000 ohms. Since R_3 is 80,000 ohms, the resistance of the valve under these conditions will be 120,000 ohms.

Since a current of 0·5 milliampere is flowing through R_3 the potential across R_3 is $0{\cdot}00005 \times 80{,}000 = 40$ volts and this acts in such a way that Z is negative. The potential of P_1 will obviously be +60 volts. Thus we see that while Z is −40 volts with respect to Y yet the opposing and greater potential of H makes the potential of Z − 40 + 100 or + 60 volts with respect to the filaments.

Now let us imagine that a half oscillation has made G_1 positive with respect to F_1. The current through R_3 increases. Consequently the potential across R_3 increases and Z becomes still more negative with respect to Y and this potential of Z with respect to the filaments may fall from +40 volts to say, +39 volts. The potential of Z and also P_1 has thus become relatively negative to the extent of 1 volt.

In the circuit shown, we communicate these voltage changes across the plate circuit of the first valve to the grid G_2 of the second. This may be done by connecting a small condenser C_2 of about ·00005 mfd. between Z and G_2. If Z were connected directly to G_2 the potential of G_2 would normally be +40 volts, a most unsuitable value. By using C_2, however, the potential of G_2 is in the neighbourhood of zero volts. The condenser C_2, however, will allow of pulsating or alternating E.M.F.s to pass through it. Consequently when the potential of Z suddenly changes from +40 to +39 volts, the grid G_2 acquires a *momentary* potential of −1 volt which will decrease the plate current of the second valve. A negative half cycle applied to G_1 would decrease the plate current of the first valve and so increase the resistance of the valve. The current through R_3 will decrease and so the potential across it. The potential of Z with respect to Y will now be, say, −39 volts instead of −40. The potential of Z with respect to the filaments will be −39 + 100 = +61 volts. The potential of Z has thus become positive with respect to F_2. This momentary increase will make G_2 positive with respect to F_2 and the plate current of the second valve will tend to increase.

In this manner oscillations may be passed on from valve to valve, each valve increasing the amplification. The last valve (the second in this case) may be made to act as a detector, and telephones included in its plate circuit. In the circuit under consideration a

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high resistance R_4 of about 5 million ohms (megohms) is converted as shown. This leak prevents the accumulation of a negative charge on G_2.

Fig. 16 shows a four valve receiver. The first three valves are intended to operate as amplifiers of the oscillations and consequently it is preferable to give their grids a slightly negative potential. This has been accomplished by inserting a resistance R as shown. This resistance may have a value of about 1 to 1·5 ohms and ensures that all the three first grids will have a negative potential. This potential, it will be noted, acts through the 5 megohm grid leaks since the grid current is negligible and consequently there is no voltage drop across these resistances. The last valve acts as a detector and might, if desired, have a separate filament rheostat.

Increased amplification is obtainable on these circuits by employing retroaction. It has been stated that when the first grid is momentarily positive, the first plate becomes relatively negative, the second grid negative, the second plate positive, and so on. If now we connect a very small condenser between the first grid and one of the subsequent plates which possesses the same potential sign at the same moment retroactive amplification will take place. This condenser is preferably variable and should have a capacity of about 0·00005 mfd.

Retroaction may be obtained by making connections between any two points which have the same potential sign. Thus, the condenser might be connected across the grid of the second vacuum tube and the plate of the third or fifth tube. It is usually preferable to obtain the desired retroaction by making the coupling between two plates of similar sign, such as the 1st and 3rd, 1st and 5th, 2nd and 4th, and so on.

If the degree of retroaction be sufficiently increased, the circuits will oscillate of their own accord at a frequency which may be varied by adjusting the aerial condenser. The amplifier may then be used as a continuous-wave receiver.

In place of a coupling condenser, a high resistance of about 10 megohms has been suggested, but the retroaction is not then conveniently variable.

An important advantage of resistance amplifiers over iron-core amplifiers, is that they are quieter in action. This is due to the fact that the small grid condensers offer a high resistance to the low-frequency variations and

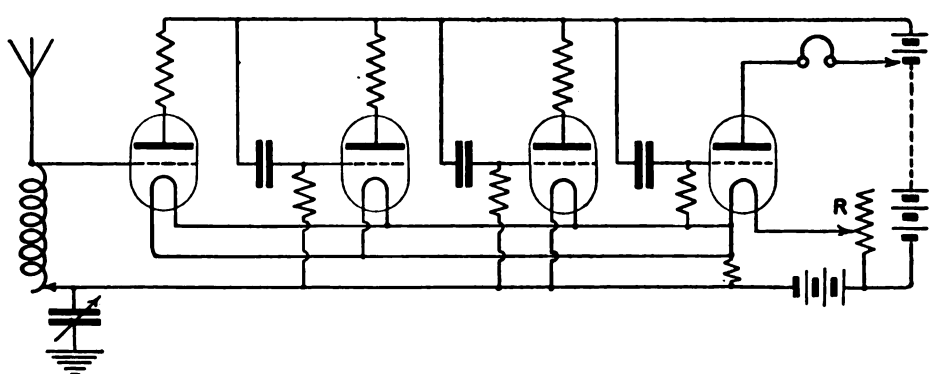

Fig. 16. Four-valve Resistance Amplifier.

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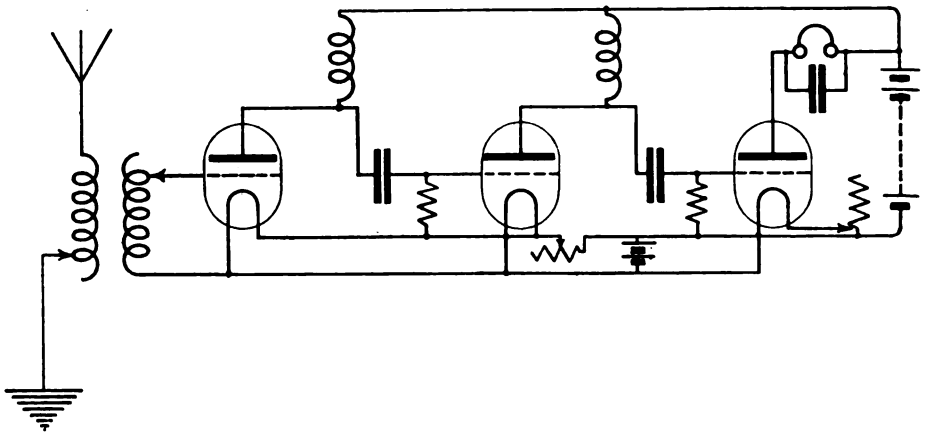

Fig. 17. Impedance Amplifier.

irregularities of plate curent which usually produce the noises. On the other hand, they readily allow high-frequency potentials to be transmitted through them.

Resistance amplifiers are most efficient on wave-lengths lower than 600 metres. This is because there is always a certain unavoidable capacity acting in shunt to the plate circuit resistances. High-frequency current will prefer to pass across this capacity than through the resistance. The effective impedance offered by the plate circuit resistance is decreased and the degree to which it is decreased will depend on the capacity and on the frequency of incoming signals. The greater the frequency the less will be the resistance of the capacity and the less the total impedance. Consequently, resistance amplifiers are not usually very efficient on short wave-lengths.

In place of non-inductive resistances, impedance coils have been used. Coils made by winding about 400 yds. of fine wire on an iron core may be used in place of the resistances. These amplifiers are more suitable for low wave-lengths since the impedance of such iron core coils increases with the frequency. The efficiency of such an amplifier would, however, vary according to the wave-length since the impedance depends on the frequency and the efficiency on the impedance. Fig. 17 shows such an impedance amplifier.

Since the Authorities have now made a preliminary announcement with regard to amateur licences we hope very shortly to give practical dimensions and details of some valve receiving circuits. We would particularly draw the attention of the amateur to the fact that it is necessary to obtain special permission from the Postmaster-General before installing or using any receiving circuits involving the use of three-electrode valves.

TO APPEAR SHORTLY.

A valuable article on A.C. work in connection with Triode Circuits, by Mr. R. C. CLINKER, of the Wireless Society of London.

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The Amateur's Guide to the Aether

WEATHER REPORTS FROM THE AIR MINISTRY.

A METEOROLOGICAL programme is circulated three times daily (at 8.15 a.m., 9.15 a.m., and 8.15 p.m., all G.M.T.). by the Air Ministry Wireless Station (GFA) situated at the top of India House, in Kingsway, London. It is transmitted by the C.W. system on a wavelength of 1,400 metres. We are now able to publish particulars of the special code used for this programme, to enable those of our readers who may wish to intercept it, to transcribe the messages received. The programme consists of a *précis* of meteorological reports received by the Air Ministry Station from all parts of the country.

We had the pleasure recently of visiting the station referred to above and shown in the illustration. It is the main control station of the Air Ministry and is used chiefly for the collection and dissemination of aviation meteorological reports and for controlling the British aerial service, both R.A.F. and commercial.

The installation includes two continuous wave transmitters, one of which, possessing a useful wireless range of 400 miles, is employed for transmitting all messages to places in the British Isles; and the other, of higher power, with a useful range of approximately 1,500 miles, is employed for communication with Paris, Brussels, Norway and Holland and many other places.

The observations which are transmitted at the times mentioned above, are made at 10 a.m., 7.0 a.m., and 6.0 p.m. (G.M.T.) respectively.

The message is arranged in two parts, the first part consisting of weather information from the following stations:—

101 Lerwick	150 Dungeness
195 Stornoway	174 Holyhead
199 Blacksod Point	162 Portland
182 Malin Head	110 Aberdeen
192 Valentia	118 Tynemouth
166 Scilly	136 Yarmouth

The identification number of each Station is followed by two groups of five figures which are arranged thus:— BBBDD FwBbb, and have the following significance:—

BBB—Barometer in millibars and tenths. The initial 9 or 10 is omitted.

DD—Direction of wind in points (02—NNE 16—S, etc.).

F—Force of wind on Beaufort Scale. (See Code I.) not m.p.h.

w—Present weather in international code. (See Code II.).

B—Characteristic of barometric tendency (See Code III.).

bb—Amount of barometric tendency during the previous 3 hours. (50 added for fall).

The first and second parts of the message are divided by one group of four X's.

The second part of the message consists of upper wind information from as many as possible of the following stations:—

Scotland, N., 107, Houton Bay.

Scotland, N.E., 109, Longside or 113, Fifeness.

Scotland E., 115, East Fortune, or 117, St. Abbs Head, or 119, Cramlington.

England, N.E., 123, Flamborough Head, or 125, Howden, or 131, Cranwell.

England, E., 135 Yarmouth or 137 Pulham, or 141 Orfordness, or 143 Felixstowe.

England, S.E., 147, Grain, or 149, Capel, or 151, Polegate.

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Midland Counties, 173, Turnhill, or 139, Bedford.

Southern Counties, 153, Calshot, or 155, Stonehenge.

Channel, 161, Portland, or 163, Plymouth.

England, S.W. 165, Mullion.

S. Wales, 169 Pembroke.

England, N.W. & N. Wales, 175, Anglesey, or 177, Barrow.

Scotland, S.W., 179, Luce Bay, or 181, Inchinnan.

Ireland, N., 183, Malin Head.

Ireland, E., 184, Baldonnel.

Ireland, S.W., 191, Beerhaven, or 192, Valencia, or 189, Queenstown.

The identification number of each Station is followed by two groups of five figures arranged thus HDDVV and will have the following significance:—

H—Height.

DD—Wind direction in point (02—NNE 16—S., etc.).

VV—Wind speed in miles per hour.

The first of these groups gives the wind direction and speed at either one or two thousand feet, the height being indicated by the first figure of the group.

The second group gives the wind direction and speed at a height between three and ten thousand feet, the height being indicated by the first figure of the group. Ten thousand feet is indicated by the figure 0.

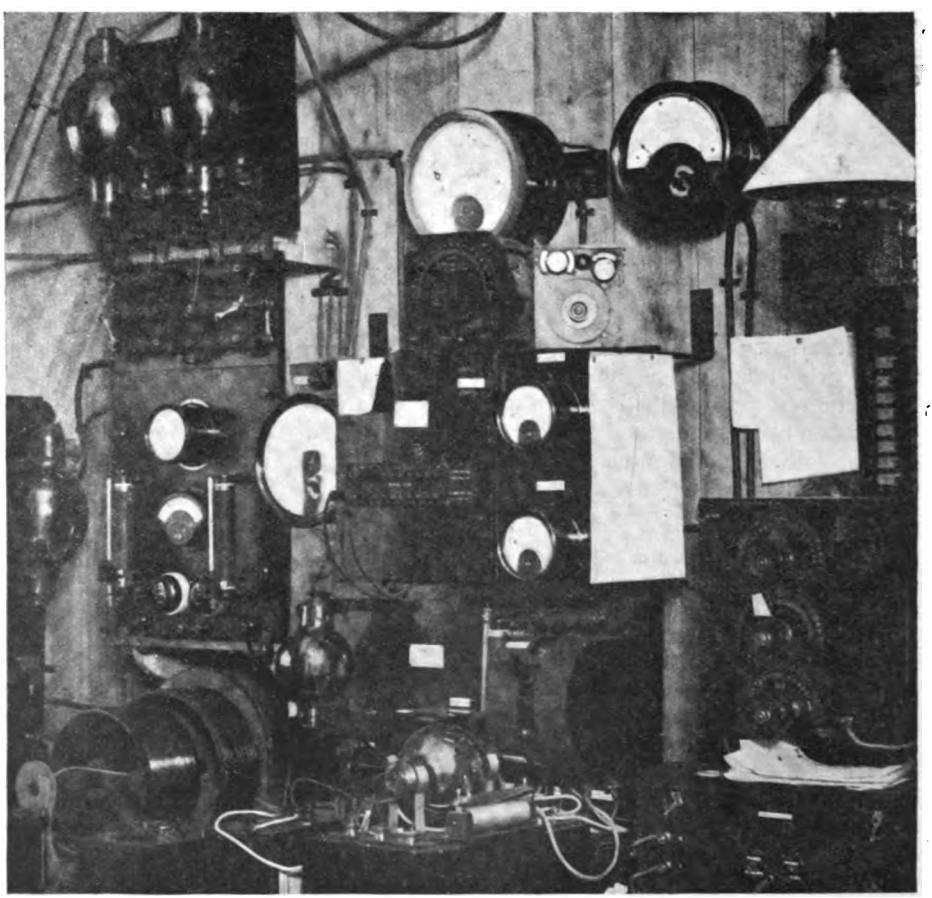

Photo. Photo Press.

Some of the apparatus at the Air Ministry Wireless Station.

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CODE I.

Beaufort Number.	Miles per hour.	Metres per second.
0	Less than 1	Less than 0.3
1	1— 3	0.3— 1.5
2	4— 7	1.6— 3.3
3	8—12	3.4— 5.4
4	13—18	5.5— 7.9
5	19—24	8.0—10.7
6	25—31	10.8—13.8
7	32—38	13.9—17.1
8	39—46	17.2—20.7
9	47—54	20.8—24.4

Wind Force above 9 is sent as 9.

CODE II.

0—Blue Sky.
1—Sky ¼ cloudy.
2—Sky ½ cloudy.
3—Sky ¾ cloudy.
4—Sky completely overcast.
5—Rain falling.
6—Snow falling.
7—Mist
8—Fog.
9—Thunder.

CODE III.

0—Steady.
1—Unsteady.
2—Rising.
3—Falling
4—Falling, then rising.
5—Steady, then rising.
6—Steady, then falling.
7—Falling, now steady
8—Rising, now steady or falling.
9—Storm indications; sudden rise with marked change of wind and weather.

THE NEW VOLUME.

THE eighth volume of THE WIRELESS WORLD, which commences in April, will bear in its general appearance and within its pages many signs that the prevailing spirit of reconstruction has not passed unheeded over the pioneer wireless magazine of the British Empire.

The most far-reaching improvement which will be effected is that the magazine will appear fortnightly instead of monthly, a change which, we are convinced, will meet with the unanimous approval of our readers. By this means we shall eliminate to a large extent the disabilities under which a monthly publication labours.

In its new form the WIRELESS WORLD will contain 36 literary pages and will be issued at sixpence per copy.

The policy of the magazine remains unaltered in its general aims, though its scope will be extended in certain directions. First, about policy. The latter can be defined in two words,—instruction and information As regards the first, special features will be introduced. For beginners in the study of radio work there will be a complete article in every issue, giving instruction in the principles underlying radio-communication and the apparatus by which this is effected. Although each article will be complete in itself, its position in the series will be carefully arranged beforehand and with a view to rendering the student's conceptions orderly and coherent. Another regular feature will be a series of complete articles by Mr. Philip R. Coursey, B.Sc., A.M.I.E.E., dealing with various radio topics and written in a manner similar to that known as the "popular lecture style," so that they may be made the bases of popular lectures, the demand for which is increasing every month.

For more advanced students we shall continue to publish technical articles by experts in various branches of radio work. Most of these articles will be specially commissioned—a procedure which will ensure that the magazine will keep abreast of the march of progress. The Digest of Radio Literature,

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always a popular feature, will be made more useful than ever by an increase in the number of articles covered in each issue, whilst the Book Reviews will, as before, deal promptly with all new books relating to wireless or allied subjects.

Our Questions and Answers Section, always full to overflowing, will be enlarged and made of greater interest to all readers by the inclusion of the questions to which the answers refer.

The important position which the amateur wireless community has attained, and the increasing number and activity of the Wireless Clubs point to the need for an Amateur Wireless magazine especially devoted to the instruction of novices and to the needs of private experimenters and clubs in respect to the construction of apparatus and the design of installations. These functions will be exercised by the WIRELESS WORLD, which has always endeavoured to forward the aims and interests of amateurs. As the official organ of that influential body, the Wireless Society of London, we shall publish verbatim reports of its proceedings, which means that many important and original papers will appear in our pages, together with discussions of the same by front-rank radio workers. A generous amount of space will be allotted to reports and notices of all the other Wireless Clubs, including those of other countries.

An entirely new feature of the magazine will be the inauguration of an Exchange and Mart Section, the advantages of which scarcely require description.

Finally, our policy is to give our readers the fullest possible information about the world of wireless, its personalities, its progress all over the world, its commercial aspects and the general trend of thought, research and development. It is impossible to overlook the importance of wireless as used in conjunction with aviation, and we have, therefore, arranged to publish regularly every six weeks an article dealing with the progress of commercial aircraft wireless, so that the completed volume will contain a record of the year's development of this phase of the art.

COMPETITION FOR COMMERCIAL WIRELESS OPERATORS

Names of Prize Winners

The competition which started in our September issue was an attempt to stimulate the powers of observation of Wireless Telegraphists, and, at the same time, to gather data which might prove useful in the resolution of the various outstanding problems of æther-wave phenomena. We hoped that the generous prizes offered and the manifold opportunities for observation enjoyed by operators would result in a large number of entries, but the number of competitors was not large. Perhaps the chief reasons for this are that many sea-going operators in distant parts of the world failed to learn about the competition and many others, on large passenger ships, were too busy about their wireless duties to be able to make regular observations. Not one attempt has been received from shore operators. The names of the prize-winners are as follow:

1st prize, Twelve Guineas, Mr. J. Williamson, 114, Duke Street, Leith.

2nd prize, Six Guineas, Mr. J. Cunningham, 35, Liverpool Street, Walworth, S.E.17.

Consolation prize of Books, Mr. E. A. Payne, "Hill Crest," Honywood Road, Colchester.

Consolation prize of Books, Mr. C. H. Beckway, 44, Blandford Road, Beckenham, Kent.

The other two consolation prizes have not been awarded because in no other instances were the papers submitted considered to contribute anything useful to the present stock of knowledge.

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Notes of the Month

FRENCH NAVAL COASTAL WIRELESS STATIONS.

AN Admiralty Notice to Mariners (92 of 1920) states that the French Naval coastal wireless Stations established in France and Algeria are no longer to be used for commercial services; only the Stations under the administration of the Post, Telegraphs and Telephones will be used for this purpose; these Stations are as follows—

Boulogne—Ostrohove.
Havre—Bleville.
Ouessant (Ushant).
Bordeaux—Le Bousoat.
Marseilles—Jetée.
Cros de Cagnes (Nice).
Bonifacio.
Port de l'Eau.

The Direction-finding Station Barre de l'Adour (Bayonne) can, however, be used for local commercial services by vessels bound to or from Bayonne.

The French Naval direction-finding Stations will remain at the disposal of merchant vessels of all nationalities; this service will not incur any charge.

In Tunis, Morocco, and the French colonies the Naval wireless Stations will continue to be available for commercial services. In Tunis, however, merchant vessels should for preference use Cape Bon Station; Sidi Abdullah Station will only intervene in case of difficulty in communicating with Cape Bon Station.

The Naval Stations can still be utilised by the Allied warships desiring to communicate with the French Naval Authorities; they will follow the Inter-Allied procedure in force.

THE STEADY MARCH OF WIRELESS.

A wireless telephone equipment is being installed by the Public Service Company of Northern Illinois at its Blue Island and Joliet Stations, which Stations are 25 miles apart. The telephones will have a range of about 100 miles, and will safeguard communication in the event of the wire lines being for any reason put out of commission.

We understand that a wireless telephone system throughout the northern territory of Manitoba, to bring it into touch with the cities of the West, is recommended by the Commissioner.

Direction-finding Stations are to be employed by the Marconi Company on an airway route for the purpose of demonstrating the use of wireless telephony in aerial navigation. Successful experiments in wireless telephony have also been carried out by that Company between Chelmsford and a station 20 miles east of Amsterdam, with portable sets that can be carried on mules.

A demand for telephonic communication in British Columbia has arisen as a result of recent gold discoveries in the Yukon, and a Yukon member of the Overseas Club has asked the Overseas Trade Bureau to put him in touch with a firm which can supply wireless telephone sets capable of connecting Dawson with a camp 200 miles away.

From Pittsburg comes the interesting news that 400 owners of wireless telephones in that part of the United States enjoy concerts nightly by means of their instruments.

According to the *Liverpool Courier* of December 31st last, the U.S. Government is being asked by the

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Admiralty for a report on a new phase of wireless telephony, which it is claimed will make it possible to focus radio messages sent out, as well as to attract and compel them to travel in close vicinity to the attracting wire. It is stated that Major-General George O. Squier, Chief Signal Officer of the United States Army, has perfected a system permitting ten or more telephone conversations to be transmitted simultaneously.

A proposal has been mooted to erect a wireless station on the coast of British Columbia, having a range of 6,000 miles, which would establish direct wireless communication with the Orient.

With the gradual return of normal conditions, many fresh wireless "links" are being forged. In the near future, the following services, amongst others, will be opened:

United States—Gt. Britain (terminal stations at Belmar, New Jersey, and Carnarvon, Wales).

United States—France (terminal stations at Tuckerton, New Jersey, and, probably, Bordeaux).

United States—Scandinavia (terminal stations at Marion, New Jersey, and Stavanger, Norway).

A direct wireless service between North and South America is also under consideration.

It is announced from Rotterdam that Messrs. L. Smit & Co.'s wireless station at Maassluis has been re-opened.

The Uruguayan Legislative Chambers have been recommended by the Uruguayan Council of Administration to authorise the Department of Wireless Telegraphy to contract for a loan of $200,000 (Uruguayan gold) to enable improvements and extensions to be effected in the wireless services.

According to the *Electrician*, it is announced that the Italian Government, having found the wireless service between Carnarvon and Rome more efficient than others, has instructed its delegation in Paris to adopt the Carnarvon-Rome route for all its important messages.

* * *

GALE WARNINGS BY WIRELESS.

The Admiralty has decided to institute a wireless service of gale warnings for ships at sea. The warning will be issued by various British coast stations when the strength of the wind is expected to reach or exceed 40 miles per hour, and will probably take the following form: (example): "Gale probable from S.W. and W., Irish Sea and Bristol Channel."

* * *

WIRELESS DIRECTION-FINDING.

An extremely interesting and instructive paper on Radio Direction and Position Finding, was read by Capt. H. J. Round before a meeting of the Institution of Electrical Engineers held at the Institution of Civil Engineers, on Jan. 14th. Captain Round dwelt on the history and the improvement during the War of Direction-Finding by Wireless.

* * *

BRITISH SHIPMASTERS' DINNER.

A dinner open to all British Shipmasters throughout the Kingdom will be given at the Adelphi Hotel, Liverpool, on Wednesday, March 3rd. Tickets, £1 1s. 0d. each. Obtainable from Captain P. O. Griffiths, Superintendent, Mercantile Marine Office, Canning Place, Liverpool. It is hoped that as many Shipmasters as possible will attend.

* * *

CATALOGUE OF WIRELESS APPARATUS.

We have received an attractive catalogue of standard condensers and wireless apparatus manufactured by H. W. Sullivan, Winchester House, London. An illustration of each instrument is given, with its price and particulars of special features.

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The Proceedings of the Wireless Society of London

Ordinary General Meeting held in the Lecture Hall of the Institution of Civil Engineers, on Thursday, January 29th, 1920. The President, Mr. A. A. Campbell Swinton, in the Chair.

The SECRETARY having read the Minutes of the last meeting, and these having been passed and signed as correct, the PRESIDENT called on Mr. R. C. Clinker to deliver his lecture. This was followed by a discussion and a vote of thanks to the lecturer.

The CHAIRMAN (Mr. F. Hope-Jones), with regard to the scheme for the affiliation of the provincial and suburban clubs to the Wireless Society of London, then said:—

Mr. President and Gentlemen,—We sent out our invitation to fifteen wireless societies—all that we could hear of—early this month. Of those, I think I can say there have been no refusals of our proposals, but from three we have received no reply. I think the reason must be attributed to the fact that they have probably not resumed their activities yet. Five have definitely accepted our proposals, and the remainder have asked for more precise information of what we suggest.

The Committee having gone very carefully into the whole question of affiliation, have made certain definite proposals which are now being formulated to all. In the first place, the idea is that all members of every affiliated society shall have a general invitation to our monthly meetings, providing themselves, of course, with a note of identification from their secretaries. That will mean, I hope, that members of various provincial societies when they happen to be in town at the date of our meeting, will be in our audience. Then the affiliation of the society carries with it the offer of a membership to one of the officials of that society; whether the Secretary, or Chairman, or President, it is for them to say. They will make the election themselves, naturally. That member of each society will become a member of the Wireless Society of London. The intention is that we have ready for the disposal of each of the affiliated societies reprints of all the papers that are read before us here in London. It is intended to give a dozen copies of each, and if notice is given of any further number required they will be provided at the cost of printing and paper.

The proposals generally have been welcomed, and not least the suggestion that the societies shall add to their titles, "Affiliated to the Wireless Society of London." The greatest advantage that I think the whole scheme has to offer is a conference; it is proposed to hold one every year, making a beginning next month here in London. It is assumed that we shall not travel from town to town like the British Association, but that our conferences, for the present, at any rate, shall always be held in London; and it is suggested that the coming month is proper, because at the end of next month we are overdue with our Presidential address—which will be the subject of our next general meeting—and I am sure you will agree with me there will be a very fitting opportunity to invite members or delegates from various provincial societies to join us on that occasion. The date has been fixed for Friday, 27th February, when the President will give us his address at the Society of Arts, for a reason which he will explain to you. It is hoped that the conference will be called for the same afternoon, probably in the same building. The idea is that the invitation to the conference is absolutely general to any member of an affiliated provincial society who happens to be in London. I have no doubt many societies will actually appoint delegates to attend it.

I need hardly say we are alive to the desirability of having the very latest information from the "powers that be" with regard to legislation, and perhaps with regard to slackening the rules a little bit; but that must be left to the Committee of the Wireless Society of London, and cannot very well be discussed in public.

I ought to add that the fee for affiliation of each wireless society has been fixed at one guinea, with an annual subscription of one guinea. All those who have referred to it have accepted it at once as a reasonable request. I think that is all that need be said on the subject of affiliation at the present time. You will understand I am only anticipating

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by a post or two the official announcement that will be communicated to each of the societies concerned.

The PRESIDENT: It only remains for me to announce the fact that the next meeting will be held on the 27th February, and that it is proposed to hold the meeting at eight o'clock because it is thought that is a more convenient hour than six o'clock, the time at which the meeting must start if held in this building. It had been intended that the next meeting should be in this building, but I thought that probably you would like to have some experiments shown you, especially the reception of wireless signals from a distance without any aerial—simply on a coil. Unfortunately this building is very unsuitable for the purpose. It is entirely framed in iron girders, and experiment has shown that it is very difficult to get the signals on an inside aerial in this room at all. If you are going to show things of that kind to a large audience you want to get the signals fairly powerful; but with a three-valve amplifier in this room and a big coil we could not get anything at all. Outside, away from the girders, we got the signals at once; but this room is very unsuitable. We considered whether it was possible to apply to the Institution of Mechanical Engineers, which is close here. That is an old building, and not built, I think, in the way this one is; but unfortunately immediately at the back of it there is a very large building all framed in iron—just like this building—and I am afraid that we might there also have difficulty in getting strong signals. But the Society of Arts building was built by the brothers Adam about 1740, before iron girders were known; so I think we are fairly safe in going there. There is a trouble there—the alternating current. Some roof experiments I have made there show that it is not very conducive to the desired result; but I think we can get over that, and it is proposed the meeting shall be held at the Society of Arts at eight o'clock. Among other things I have got word from General Ferrié of the Eiffel Tower that he will be pleased to do what he did before in 1914—to send us a special message, which I hope to make audible to you. The meeting is now adjourned until February 27th.

A PORTABLE SET, AND SOME PROPERTIES OF C.W. CIRCUITS.

By R. C. CLINKER.

There are many members of this Society who have had a good deal to do with valves during the last five or six years, and who, of course, know a great deal about them. On the other hand, I think there are many members who have not had the opportunity, and are now beginning to use them and to learn the various customs of the valve. I thought I would make this lecture rather elementary,—at any rate to the first class, if they will excuse it,—because very familiar things may be put in, perhaps, new ways, and discussion afterwards is always very helpful.

I propose to do a little demonstration with this set and will describe it first. (Figs. 1 and 2.) It was intended as a complete unit primarily for obtaining time signals from Paris, and it combines all the apparatus in one case. It is rather a dreadful thing, from a wireless point of view, to put a lot of metal in the middle of a receiving coil, and it means a certain amount of damping; but with these two valves one can get quite good signals from Paris. The cover is made movable, and there is a central pivot so that the whole set can be rotated to obtain the approximate direction of signals. There is a compass fitted in the cover, which enables the latter to be laid down in the right direction, and the desired station can be found by turning the box round. This set will pick up such spark stations as Paris, Nauen and Poldhu; the C.W. stations come out a good deal better. Fig. 3 is a diagram of the connections, and there is nothing unusual about them. The receiving coil is wound completely round the inner frame, and the valve on the left is the detector. The main tuning condenser is shown on the left. There is also a reaction coil, and a transformer which connects to the amplifying valve. The filament battery is shown on the right. This set will not pick up spark stations to any extent unless it is oscillating. In other words, you do not get the true note, you get the "scratch"; but for time signals it is quite

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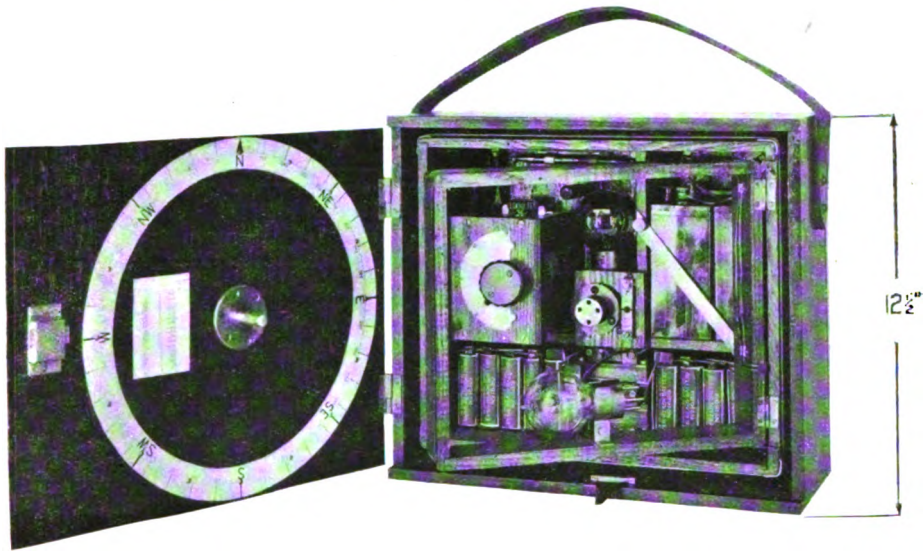

Fig. 1. Portable Receiver, showing pivot on detachable cover.

good. There is no difficulty in getting Paris even when there is a fair amount of disturbance. We have also picked up wireless telephone signals with it, and heard speech. There is a plug for putting the filaments in circuit which can be seen to the right-hand side of the centre where the socket for the amplifier

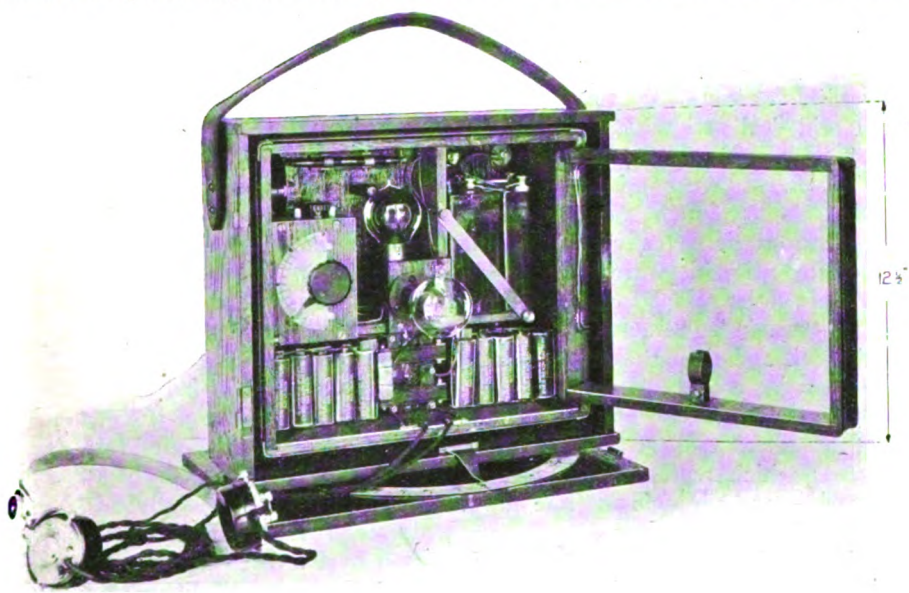

Fig. 2. Portable Receiver on pivot.

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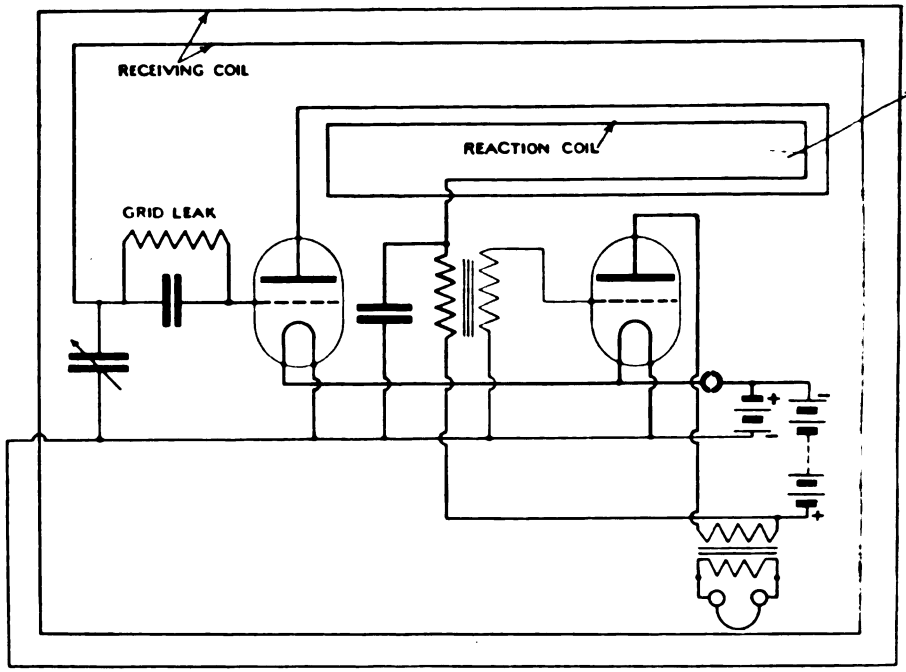

CONNECTIONS OF PORTABLE RECEIVER

Fig. 3.

is. That plug has a long handle, so that the box cannot be closed while the filaments are alight. The whole box can be readily carried.

I will deal first with the action of waves on a coil receiver such as is used in this set. If we consider the waves coming along to such a coil, we have the electro-static wave vertically, and the electro-magnetic wave horizontally. The wave sweeps along from the stations we are receiving, and cuts first one side of the coil and then the other, so that an alternating electro-motive force is induced first in one side of the coil, and then the other. I have a model here (Fig. 4) which represents the electro-magnetic wave advancing. The lower part (white) represents the wave, which can be moved horizontally in guides to represent it passing the receiving loop. The two white vertical arrows which rest upon the wave model and are moved up and down by it as the wave is moved along, represent the e.m.f.'s. induced in the two sides of the receiving coil or loop. These e.m.f.'s are equal and almost opposed in phase, but not quite, and it is the " not quite " which allows us to receive signals. In the illustration these arrows are shown close together, representing a narrow loop relative to the wavelength. The horizontal lines at the top form a scale for indicating the magnitude of the e.m.f.'s. The resultant e.m.f. in the loop is the algebraic difference between the e.m.f.'s. induced in the two sides. Suppose the coil is one foot long, and the wave five thousand feet long, you get a difference of phase of 360 degrees divided by 5,000, or only 0·072 of one degree. It is a tribute to the sensitiveness of the valve that you can detect such an exceedingly small difference of phase. Of course, if you make your coil wider you get a bigger difference of phase

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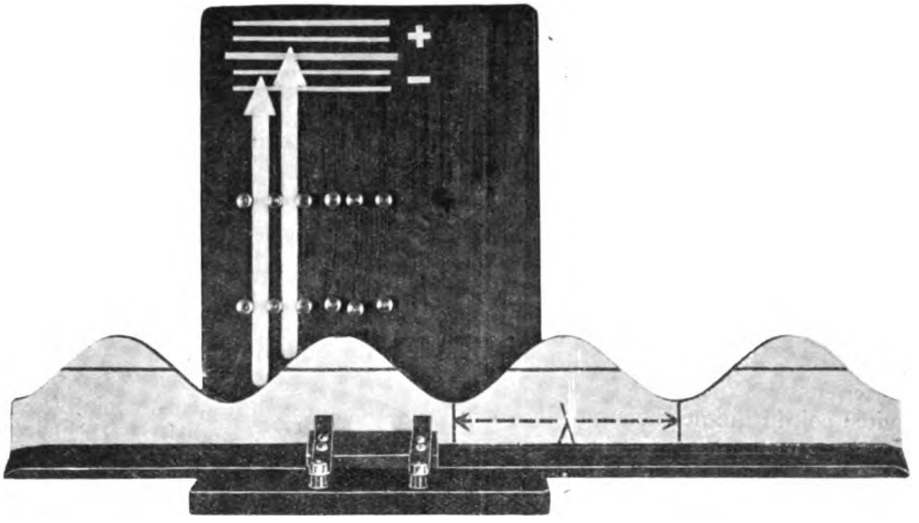

Fig. 4. Model showing action of waves on coil aerial.

between the two. This may be shown on the model by moving the right-hand arrow into one of the other guides. If you spread out your coil to a half wavelength you get as a resultant the full electromotive force which is induced in one side of the coil.

An oscillating set like the one shown (Figs. 1 and 2) is exceedingly useful for getting comparative measurements of inductances and capacity, and there is a method, which we may call the " double click method," which was referred to in the discussion on Mr. Scott-Taggart's recent paper, and also in the current issue of the WIRELESS WORLD. It is an exceedingly good method of comparing inductances and capacities. I have a diagram here which I think fairly well explains itself. (Fig. 5.) Suppose we are receiving a station, or have an oscillating set which is giving a certain frequency, and also have another one which we can mistune to a certain extent and so produce a beat note as shown on the diagram. I have marked the diagram in percentages; for instance a one per cent. increase of $L \times C$ means that your frequency has decreased roughly by one-half per cent., giving 500 vibrations per second; the 1.2 per cent. corresponds to 600 per sec. That diagram is approximately right, and near enough for the small changes marked at the bottom.

Now if you put a coil, which we will call A, in the neighbourhood of a circuit B, the effective inductance of B is modified. I use the term "effective inductance" in doing this experiment to show that B behaves as though its actual inductance were changed. We have now one set giving a standard,

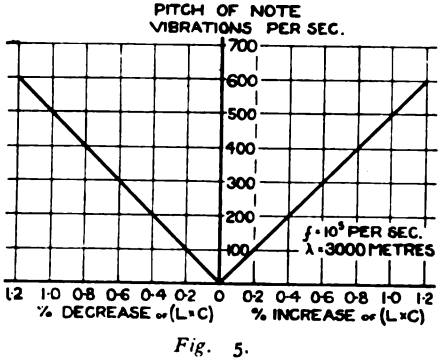

Fig. 5.

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steady frequency. (The valve circuit is really a most convenient thing, because you can start it oscillating, and it will keep up the same frequency to one part in ten thousand until you want to change it.) What I propose to do is to tune this second set (coil B) exactly to the bottom of the curve (Fig. 5.) I am now going to decrease *C* and bring the note up approximately to the top of the line; I will ask you to assume that the note is somewhere up on the left-hand side. In the first place, consider the effect of a short-circuited coil in the neighbourhood. We have a certain magnetic flux from the oscillating coil B, cutting this other one, A; that produces a current which is a quarter of a period behind the electromotive force. The consequence is that the currents in A and B are practically opposite in phase, with the result that the effective inductance of B is diminished because the flux passing through it is reduced. When this coil is short-circuited you hear that the inductance is reduced as the note rises. This shows that the current in the coil A is circulating in opposition to the current in B. Supposing now we connect a condenser of not too large a capacity to coil A, you will notice that the current in that coil is exactly reversed from what it was before. The pitch of the note comes down. When we have a small capacity connected the current flows in the same direction as the primary current; when we short-circuit the coil we have the currents in opposition; there is, therefore, a change of half a period between these two conditions.

There is a very good mechanical analogy in the reed frequency indicator. In the slide shown on the screen all the reeds are vibrating with the same frequency. Assume that the one which is in the middle is tuned to 85 cycles a second. Reed No. 84, which is next, to the left, is vibrating also 85 cycles to the second, lagging behind about 90 degrees in opposition. On the other hand, the reed to the right of the vibrating one, whose natural period is 86 cycles a second, is forced to vibrate at 85, and in trying to vibrate faster it advances 90 degrees and is a quarter of a period in advance. Between 84 and 86 therefore you have a displacement of half a period. Suppose you look at the instrument through a stroboscopic disc, you will see the instantaneous position of all these reeds. Fig. 6 is a view taken as it appears through a stroboscopic disc and you will notice that Reed No. 85 is in resonance at the moment. You are looking at it as it is moving through the centre position. Reed No. 84 is displaced a quarter of a period downwards and 86 a quarter of a period upwards. You can there see the full displacement as you pass through resonance.

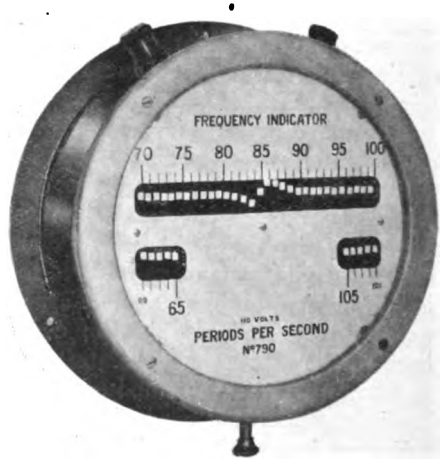

Fig. 6. Frequency Meter, as seen through stroboscope.

That is a very good analogy of the electrical circuit where, when you pass through resonance, you get a complete sweep round of the phase from 90 degrees lag to 90 degrees in advance.

This coil A has about eleven millihenries inductance. I start with the con-

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denser at zero. At present there is no capacity and no oscillating current in A. As I increase the capacity I begin to get a current, which is leading and in phase with the primary. The result is it is increasing the inductance of coil B and the pitch gradually comes down the line (of Fig. 5) to a certain point. As we approach the tuned position, at a certain point we get instability, and then the phase of the current changes right over. The current is now lagging, the note goes up beyond the top of the line, and as you increase the lagging current it comes down to where it was at the start. If you decrease the capacity the jump occurs at a slightly different point. That is what happens when we tune a separate circuit to an oscillating valve circuit, and it is that which is the basis of this method of comparing inductances and capacities. We can move away the coil A so that the points at which these quick changes occur come very close together, and between these points you are in exact tune with your valve circuit. Suppose we want to measure an inductance or compare it with coil A, we take our standard inductance A, connect it with a condenser, and then couple it so loosely to an oscillating valve circuit that the two clicks come together. Repeating this experiment with the unknown inductance we can calculate its value by the reading on the condenser. It is a very convenient method, and gives very accurate results. Fig. 7 shows how the current changes in the circuit. The readings were taken in a coupled circuit, and the Fig. shows the current in the coupled circuit as the condenser is increased from zero upwards. Starting with point A the capacity is very small, and the current is leading by 90 degrees; in other words, it is exactly in phase with the current in the primary. Starting with point A we go up the curve always with a leading current; when we get to B the circuit is very nearly in tune. This is a point of instability and the current drops down to C on another curve. Still increasing the capacity it goes on towards D. When we come back, we come up the lower curve, which is a curve indicating another frequency, on to point E and back to A. There are thus two frequencies present; those frequencies exist not together, but separately, but their values are the same as obtained with two damped circuits such as in a spark transmitter. In the spark circuit the two frequencies occur simultaneously, whereas with the C.W. circuit they occur separately; but their values are the same, and depend on the inductance, capacity and coupling of the two circuits.

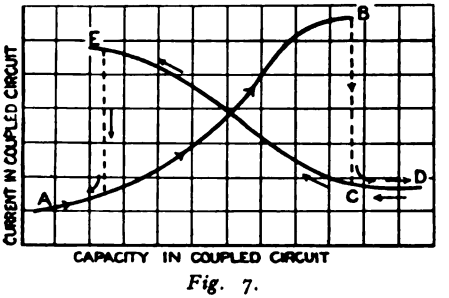

Fig. 7.

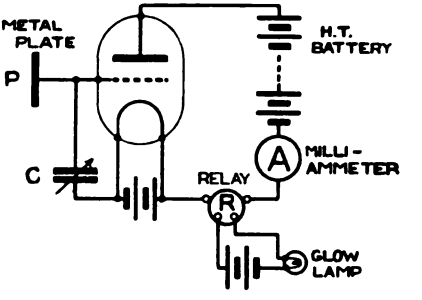

Fig. 8.

I have one other experiment I think perhaps will be of interest; it concerns the leakage off the grid of a valve. The arrangement is indicated in Fig. 8, the grid of the valve being insulated. The instrument A shows the plate current of the valve. The grid is insulated, but

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is connected to the variable condenser C, which is joined between the grid and the negative terminal of the filament. It is rather interesting to notice that in a valve with the grid insulated the electron discharge from the filament hits the grid so that it becomes electrically charged. Supposing the condenser C is put to its full capacity it then becomes charged up by the electrons. If we make a sudden reduction in capacity the negative voltage of the grid is increased, and the plate current is stopped. I have connected a relay R and a little lamp which lights up when the plate current is flowing. When we discharge the grid with the finger the plate current starts again. It is curious to see the effect of radium. Radium renders the air conducting in its neighbourhood, and will therefore discharge an electrically charged body when brought near the latter. It will be noted that uninfluenced by the radium the charge on the grid takes about 5 seconds to leak away before the plate current flows again and the indicating lamp lights up. On approaching the radium to the metal plate P, the charge takes only one second to leak away. I do not know whether I have made the experiment quite clear. Assuming that the capacity of the condenser is decreased about 70 times from maximum to zero, the negative potential of the grid will be increased 70 times. Hence, if the original voltage of the grid is minus 1 volt, it will fall to minus 70 volts. That is a very considerable potential so that the plate current goes right down to zero, and the charge takes some time to leak off. This forms a good way of showing that the grid naturally becomes negative if it is insulated.

DISCUSSION.

The PRESIDENT: I am sure we are very much indebted to Mr. Clinker for coming and showing us these very beautiful experiments and this very interesting apparatus. I dare say that some members will like to ask some questions and also to discuss the results he has brought before us. The paper is now open for discussion.

Professor G. W. O. HOWE: Mr. President, I am sure we are all very much indebted to Mr. Clinker for showing us these beautiful experiments and also for explaining them in such a clear and lucid manner. I was very pleased when Mr. Clinker, in opening his remarks, said that he was going to explain them in an elementary manner, and I am sure that was a very wise thing on his part. I am afraid it is a common failing with people who read papers to fancy that their audience knows nearly as much about the subject as they do themselves. They usually start too high above the heads of their audience, and the result is that the majority of the audience spend their time in wondering what it is all about.

I am very interested in this compact, useful set. I had the privilege of seeing the original model, which was made, I think, by Mr. Clinker himself, and which he once brought to my house and with which we picked up various Continental stations in my study. I was particularly struck then by the sensitiveness of the apparatus, and the ingenious way in which it was all fitted together into such a small compass. We are having illustrations every day of the enormous change that has been brought into wireless telegraphy by the three-electrode valve. All this would have been impossible, of course, without that instrument.

I was very much interested in the fact that Mr. Clinker used a mechanical analogy to explain leading and lagging currents in an oscillatory circuit when its natural frequency changed from a frequency above that of the forced oscillation to one below the forced oscillation. I was rather amused at this, because you will find a paper of mine read some four or five years ago before the Institution of Electrical Engineers on the amplitude and phase of higher harmonics in oscillographs; and there, where you are dealing with oscillations of a mechanical system, I think I make it clearer by an electrical analogy. So, while I explain the mechanical oscillations of the oscillograph by analogy with the electrical circuit, Mr. Clinker follows the other method and seeks to make electrical circuits plainer by means of a mechanical analogy.

I was interested in the final remark with regard to the method of the double click, where Mr. Clinker drew attention to the fact that these two frequencies are the same as you get in ordinary coupled spark circuits. In coupled spark circuits you get them, as he said, simultaneously, with the result that you get beats; whereas in the continuous wave case you either get the one oscillation or the other. When I am teaching the subject of the beats in damped oscillations I usually approach it in a way not usually found in text books—I published the method four or five years ago in the Ameri-

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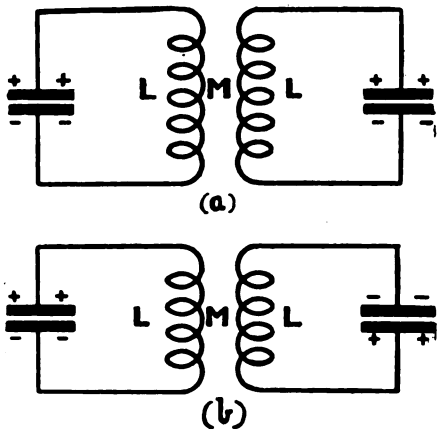

Fig. 9.

can *Electrical World*. If you have two coupled circuits (Fig. 9a) one a spark gap circuit and the other a secondary circuit, then, if instead of assuming that you have a spark gap in the primary circuit and discharge the condenser across it, suppose you assume that you break both circuits for the time being, charge up both condensers equally and discharge them simultaneously. Then, if these two circuits are tuned and have equal decrements (most of the treatment in the text-books assumes they have no decrement at all) they will oscillate together, and there will be no transfer of energy from one to the other; each circuit will oscillate almost as if the other were not there. In point of fact, because the current in one coil produces a magnetic flux in the other, that flux will either be added to or subtracted from the magnetic flux that would be in that coil were the first one not there. Now if you open the circuits again, charge the condensers in opposite directions (Fig. 9b) and then simultaneously close both circuits, the two circuits again will oscillate as before without any transfer of energy from one to the other; but here the two currents are in opposition. In that way you can prove the ordinary formulæ for the frequency of the oscillation, because the magnetic fluxes are added together in circuit (a) and you have increased the effective inductance from L to L + M—because you have equal currents in both circuits—and in the case of circuit (b) you have decreased the effective inductance of the circuit from L to L — M. That is exactly what is happening in Mr. Clinker's case. He has those two oscillatory circuits; in one case the magnetic fluxes are added, in the other they are opposing, and you get the same two frequencies.

Mr. JOHN SCOTT-TAGGART: I have been very much interested in the lecture we have just heard, and especially in the description of a novel method of measuring the length of continuous waves by the double click method which, I believe, Mr. Clinker attributes, to L. W. Austin. Members, no doubt, are already familiar with the ordinary type of oscillating wavemeter, several types of which I devised early in 1917, and have described in the *Wireless World* (Oct. and Dec., 1917), and the *Electrician* (Sept. 5, 1919). By combining two such oscillating circuits, I devised shortly afterwards a very sensitive capacity meter which I described in the *Wireless Age* (U.S.A.) of Dec., 1918, and more fully in the *Electrician* of April 18, 1919. As Mr. Clinker has described how the double click arrangement may be used to determine capacity and inductance values, my device may also be of interest to members.

The meter utilises the beat phenomenon. (Fig. 10). A circuit B oscillates continuously at a frequency which may be altered by means of a variable condenser C_2; the circuit includes a pair of telephones; another circuit A is arranged which also oscillates continuously at a frequency determined by the capacity of the condenser it is desired to test. This circuit sets up similar oscillations in the first circuit. There will, therefore, be two superimposed sets of oscillations in the first circuit; beats will be produced which when rectified will give a note in the telephones provided its frequency is within the audible limits. Now let a standard condenser C_1 of known capacity be placed

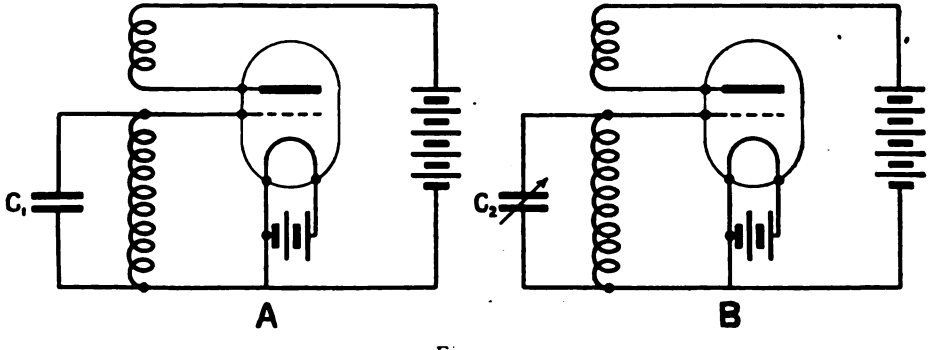

Fig. 10.

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in the A circuit. The condenser C_2 is now varied until the silent point of the beat note is obtained. A graduation is now made on C_2 corresponding to the capacity of C_1. By substituting various known capacities in place of C_1, the condenser C_2 may be graduated in suitable units. To measure the capacity of a given condenser it is only necessary to connect it in place of C_1, tune C_2 until the silent point is obtained and then read off the capacity from C_2. The device may be used in very many ways which will occur to members of the Society. It may also be used to compare inductances by a substitution method. The arrangement is exceedingly accurate, and will detect the difference in the capacity of a condenser produced by placing the hand within a few feet of the condenser whose capacity is being measured.

Admiral Sir Henry B. JACKSON: Mr. President and gentlemen, we have had a very useful discussion of how the experiments were arranged. It brings home very forcibly to one the little troubles that are sometimes experienced through the position of the receiving frames. I have had very similar experiences to others in experimenting with rather a big frame at the Royal Naval College at Greenwich. There is a good deal of metal about the building—a metal roof and a good many radiators. On the ground floor, with no radiators and very few pipes, I got very good results; but I moved the frame to the top floor and got nothing. On the intermediate floor I got certain results. For no particular reason I moved the frame two or three feet to get a bit of passage round it one day, and found I got very different results. I moved the frame about in an area not much bigger than this table, and in one place got very good signals and in another nothing whatever. I traced the cause to the radiators and the iron in the building. This experiment shows the reason of the failure.

I think the Lecturer explained very clearly the difference of phase; I never heard it put quite so clearly as that. I should like him to state what wavelengths would suit his apparatus best; can he, judging from the phase difference, say if very short waves would give the best results? Most of us, I think, find the long waves rather better on the frames than the short ones.

Mr. Philip R. COURSEY: Mr. President and gentlemen, Mr. Clinker's demonstrations this evening have been very interesting. I was particularly interested in his demonstration of the double click method, as I have used it once or twice myself, but not very extensively. The trouble I found sometimes when trying to get very accurate results was the space between the two clicks. When the coupling is reduced sufficiently to bring the clicks really close together, they become rather too faint to get sufficiently accurate results. Another method that has been used is to insert a measuring instrument such as a thermal galvanometer into the oscillating circuit itself—not merely into the plate circuit of the valve—and thus to measure the drop in current when the second circuit is brought into resonance. The effect can be shown, I think, most conveniently when there is an intermediate coupling between the oscillating valve, and what in this case is the secondary circuit—but in which in the method I am now describing would become the third circuit. The intermediate coupling can be made aperiodic, but should preferably be tuned, and the thermal galvanometer inserted in the intermediate circuit. When the last circuit is coupled up there is a very sharp drop in the intermediate circuit current, and the coupling can be reduced until the drop is made quite small, but still noticeable on the galvanometer. I am rather inclined to think that this method will frequently give more accurate results, and will eliminate any discrepancies that may arise from the two clicks not being coincident.

Mr. L. A. T. BROADWOOD: Mr. President and gentlemen, there is a method where instead of using the telephone as an indicator you have a galvanometer in the plate circuit. Then you merely tune until your galvanometer gives the greatest reading. This gives the absolute tune position with considerable accuracy. When the two circuits are in phase you get the highest reading. That method was adopted in the Government heterodyne wavemeters towards the close of the war.

The PRESIDENT: If nobody else wishes to speak I will call upon the author of the paper to reply to the discussion. I would like first of all to say myself that I think we are very much indebted to him. I think it is a great advantage, if I may say so, in a society like this, that we can have actual experiments. After all, this society is mainly an amateur body, and I think experiments really appeal to most amateurs more than the drier dissertations that one has accompanied by pictures on the blackboard, and lantern slides. Actual experiments are the most convincing kind of demonstration that one can have, and are also the type of thing that will draw large audiences such as is present this evening. We are indebted very much to Mr. Clinker for the trouble he has taken in bringing the apparatus here and demonstrating it in such a wonderful way. I would like only to emphasise what he himself said about the wonderful results that it is possible now to obtain due to the three-electrode valve which is really one of the most marvellous discoveries in physics of modern times, and enables us to take cognisance of the almost infinitely small so far as electrical currents are concerned.

Mr. R. C. CLINKER: With regard to Professor Howe's remarks, I was much interested in the demonstration he showed on the blackboard. (Fig. 10.) That, of course, is the same case as far as inductance and capacity

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of the circuits are concerned, as the continuous wave, except, as he says, that there the two frequencies—where there are two—take place simultaneously; whereas here one can separate them and get one or other at will. There are always various ways of explaining a thing; if you read a book from a man mathematically inclined, he explains things in symbols. I am interested in Professor Howe's explanations because he gives a pictorial representation which I can understand. I was much interested in Mr. Scott-Taggart's remarks; I remember reading his papers on measuring inductance and capacity. The fact is that in experimenting with variable condensers I happened to notice this click occurring, and it seemed to me an accurate way of measuring those quantities. Very likely there are other methods which would give, perhaps, as great accuracy. On the other hand, in view of Mr. Coursey's remarks, I have generally found it possible to get the clicks so close together that in some cases the mere twisting of the spindle of the condenser is enough to throw it from one to the other with a quite sharp click. Some valves gives a sharper click than others. If the click is not sharp enough I have found that closing up the coupling of the anode coil is enough to make the click quite sharp. With regard to the remarks of Admiral Jackson, as to what wavelengths these sets were suitable for, a coil like this has a great many turns of fine wire and it is not possible to get much below two thousand metres. The idea in making it was primarily to pick up Paris; consequently two thousand was the minimum we tried for. One of the sets shown goes up to 7,700 metres, whereas the other has a smaller condenser and only goes up to 4,500 metres. I have another which goes up to 10,000 metres, and with that you can get other long-wave stations. There is just one other very interesting effect one gets with valve circuits which reminds me of the running in parallel of two alternators. If you couple two alternators to the same bus-bars they will pull into step. You get very much the same effect with two valve sets if you bring them together. I can show you that. (*Demonstrating*). One of these sets is oscillating with a wavelength of about 4,000 metres. If we start the other and gradually bring the two circuits closer together, when we get to a certain coupling you will notice that the heterodyne note absolutely disappears; the two circuits pull into synchronism and oscillate together. The action is to raise the frequency of the one and to lower that of the other, so that at a certain coupling they pull together. I do not think there was any other question to answer, and I thank you very much for your kind attention.

The PRESIDENT: I will ask you to pass a very hearty vote of thanks to Mr. Clinker for a most interesting paper and the beautiful experiments he has shown us. (Applause). I have to announce that the fourteen gentlemen whose names have been circulated have all been elected members of the society.

WIRELESS CLUB NOTES.

THE WIRELESS SOCIETY OF LONDON.

With reference to the affiliation suggestion made by this Society the following are the definite proposals now put forward:—

(1) That an affiliated Club should pay £1 1s. 0d. per annum as subscription and £1 1s. 0d. entrance fee.

(2) That such a Club should adopt as subtitle, "Affiliated with the Wireless Society of London."

(3) That affiliated clubs should name each year, say, in January, one member (probably the President or Hon. Sec.), who will be during the year a member of the Wireless Society of London, and to whom all notices, etc., of the Society will be sent.

(4) That each affiliated club shall receive twelve free reprints of the Wireless Society's monthly lectures and as many more as required at cost price plus postage.

(5) That members of affiliated clubs be invited to attend meetings of the W.S. of L. when in London, a letter of introduction being given from the Hon. Secretary of the provincial or suburban club.

(6) That an annual conference or convention be held in London, all members of provincial or suburban clubs being invited.

Hon. Sec., Mr. H. L. McMichael, 32, Quex Road, West Hampstead, N.W.

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THE MANCHESTER WIRELESS CLUB.

(*Affiliated with the Wireless Society of London.*)

A new buzzer circuit has been installed at the Club Rooms, 335, Oxford Road, Manchester. There are 5 notes each of different frequency and by means of switches jamming can be introduced on any of the 5 circuits. The arrangement was designed and wired by two of the members.

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The first lecture was given on Wednesday, January 21st, by Mr. C. V. Morris. "A talk on Wireless Receivers" was the subject, and great interest was shown by the members, who took part in a discussion after the lecture.

A prize of two guineas and a valve has been offered for the best paper on "Wireless Telephony." All members are eligible to compete.

It has been decided to install an experimental receiving set at the Club's Headquarters. Members have offered to supply the necessary instruments.

New members will be welcomed and special interest is taken in the beginner. All communications to be addressed to the Hon. Secretary, Mr. J. C. A. Reid, 16, Hawthorn Avenue, Monton, Eccles.

* * *

The Derby Wireless Club.

(Affiliated with the Wireless Society of London).

The following programme of meetings and papers has been arranged. All meetings will be held at 7.30 p.m., in Room 24, Technical College, Derby, unless otherwise notified.

Wednesday, February 25.—To discuss the Club Station. Members are invited to contribute items of Apparatus.

Wednesday, March 10.—Electrical Instruments and their Calibration. Mr. A. Domleo.

Wednesday, March 24.—Wireless Telephony, with demonstration. Mr. E. S. Huson.

Wednesday, April 7.—Electrical Apparatus in the Submarine Service. Mr. R. Huson.

Wednesday, April 21.—Loop Aerials. Mr. J. Lowe. Wavemeters. Mr. S. G. Taylor.

Wednesday, May 5.—Inductance and Capacity. Mr. A. N. McInnes, B.A.

Wednesday, May 19.—Speech Amplification, with Experiments.

Wednesday, June 2.—Electric Clocks. Capt. W. Bemrose.

Notice.

Mr. S. G. Taylor has kindly agreed to act as Hon. Secretary and Treasurer during the period February 15—April 1, and it is requested that all correspondence be addressed to him at St. Mary's Gate, Derby.

W. Bemrose, Hon. Secretary and Treasurer, Littleover Hill, Derby.

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North Middlesex Wireless Club.

(Affiliated with the Wireless Society of London).

The 31st meeting of the Club was held at Shaftesbury Hall, Bowes Park, on January 28th, the President, Mr. A. G. Arthur, being in the Chair.

After the Secretary had read out a letter received from the Wireless Society of London regarding affiliation, the President said that a few words of appreciation were due to Mr. Gartland for his work as head of the Working Committee for erecting the aerial.

An attempt was made to receive signals, but owing to the temporary nature of the wiring, and the instruments being incomplete, little success resulted.

It is confidently anticipated that by the time of the next meeting on the 11th February a complete set of receiving instruments loaned by the Secretary will be available. Full particulars may be obtained from the Hon. Secretary, E. M. Savage, "Nithsdale," Eversley Park Road, Winchmore Hill, N.21.

* * *

The Burton Wireless Club.

On Jan. 21st a lecture on "Capacity and Condensers" was delivered by Mr. A. J. Selby, Mr. A. Chapman presiding. Mr. Smith, in the absence of the Secretary, stated that a letter had been received from the Wireless Society of London regarding affiliation. The question of the provision of buzzers for Morse practice was raised, and Mr. Wright offered to present the Club with one, while Mr. Batt volunteered to lend one. Mr. Chapman said that the arrangements for the installation of a horn, for use when time signals were being received from Paris, would not be much further delayed.

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A meeting of the Club was held on Wednesday, February 4th, Mr. A. Chapman (Vice-President), presiding.

The Hon. Secretary (Mr. R. Rose) read a letter received from the Hon. Sec. of the Wireless Society of London, dated Jan. 26th, regarding affiliation. The Club decided at a previous meeting to become affiliated with the London Society, and the Members were unanimously in agreement with the proposals set forth in Mr. McMichael's letter.

It was reported that the necessary sanction having been received, a Valve Set had now been installed at the Club Headquarters.

Mr. A. J. Selby explained in detail the construction of an amateur wireless set, giving a practical demonstration.

The members were instructed in the Morse Code, and concluded a very interesting evening with Buzzer practice.

The meeting held on Feb. 4th was well attended. Six new members were elected, making a total membership of thirty-six. It was decided that the following programme should be adopted: 7.0 p.m. to 7.30 p.m., Buzzer practice; 7.30 p.m. to 8.30 p.m. lecture (Technical); 8.30 p.m. to 9.30 p.m., Buzzer practice and discussion.

Hon. Sec., Mr. R. Rose, 214, Belvedere Road, Burton-on-Trent.

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THE SOUTHPORT WIRELESS EXPERIMENTAL SOCIETY.

(Affiliated with the Wireless Society of London.)

The President (Mr. E. R. W. Field) invited the members and their friends to a Social at the Drill Hall, Manchester Road, on Jan. 27th. The guests, about 60 in number, were received by the President and Mr. P. H. Christian.

The President, after welcoming the guests, gave an outline of the methods in which the Society proposed to work. He pointed out that it had been formed for the purpose of studying more deeply the subject of wireless telegraphy. It was not an ordinary "tapping club," but, as the title denoted, a wireless experimental club. They were out for good work, and would assist the Government and police authorities in preventing illicit wireless telegraphy. The apparatus they saw that evening was some which had been entirely constructed from odds and ends in the possession of members of the club, and they compared very favourably with many of the manufactured articles.

Messrs. J. Wainwright (Formby), Diggle, Lomas, Henshaw, F. Stansfield, and Christian showed and described the various exhibits to the guests. There were about 80 exhibits of members' apparatus, including loading coils, loose couplers, detectors, switches, different makes of telephones, a large assortment of crystals used in the reception of wireless telegrams and wave meters.

At the close of the exhibition, a concert was held, songs being contributed by Mrs. Lomas, Mr. Cooper, Mr. Christian, and Mr. Knock.

At the conclusion of the entertainment, Councillor Ball said he was highly gratified that such a society had been formed in Southport. It showed there was a desire by the younger of the population to study science. He would far rather encourage a number of people who were so engaged than he would a multitude of people who were given over to pursuits not of the same nature, and which were not so interesting and so helpful to the general public. He mentioned that he had been the hon. radiographer at the Infirmary 25 years, and in dealing with the X Rays he was working at the other end of the spectrum. He wished the Society every success.

Mr. Christian announced that Councillor Ball had promised to give a lecture to the Society.

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Hon. Sec. (pro tem.), Mr. F. J. S. Stansfield, 107, Eastbank Street, Southport.

* * *

The Three Towns Wireless Club.

Jan. 7th. The Hon. Secretary in the Chair. The Chairman, Mr. J. Jerritt, read a paper entitled "The Elementary Principles of Wireless Telephony," which had been communicated by Mr. E. Blake, A.M.I.E.E. A vote of thanks was passed by the members.

Jan. 14th. Mr. J. Jerritt in the Chair. Mr. Voss (late R.F.C.) lectured on "Various Wireless Systems and their efficiency." The Marconi, Poulsen, Lepel systems, and Goldschmidt's alternator were considered. It was stated that the Marconi C.W. system is very efficient.

Jan. 21st. Mr. J. Jerritt in the Chair. Mr. W. Rose (Hon. Sec.) lectured on "Telephony and the Use of the Selenium Cell in that connection." A number of interesting diagrams were shown. After the lecture and discussion the question of affiliation with the Wireless Society of London was considered. It was decided to hold the matter in abeyance.

Jan. 28th. Mr. J. Jerritt in the Chair. Mr. Lock described the construction of a condenser from simple materials.

Visitors or intending members, please apply to Mr. W. Rose, 7, Brandreth Road, Compton, Plymouth.

* * *

The Birmingham Wireless Association.

The first post-war meeting of the Birmingham Wireless Association will be held on Wednesday, March 10th, at 7.30 p.m. in Room 21 at the Birmingham and Midland Institute. All old members and others interested are invited to attend.

Many will no doubt remember that this association was incorporated in the Scientific Society shortly before the war, but very little was done before all experimenting was prohibited. Now, however, it is proposed to resume activities; the aerial has been erected and the instruments released from Post Office custody.

Will those intending to be present at the meeting on March 10th kindly advise the Hon. Secretary, J. C. Watkins, 215, Alexander Road, Acocks Green, Birmingham.

* * *

The Leicestershire Radio Society.

A meeting of this Society was held on February 6th at the Turkey Café, the President, E. Masters, Esq., occupying the Chair. There was a record attendance—upwards of 30 members being present. The speaker, Major A. L. Harris, R.E., was introduced by the Chairman, who expressed the pleasure the members had in welcoming one of the oldest of those who were associated with the old Wireless Association of pre-war days. Major Harris, in replying, said that he was delighted to find, on his return from service overseas, that the old Society had been resuscitated and also to see that it was a real live Society. Major Harris then proceeded to give an account of the part wireless had played during the recent war—in the Army.

Some interesting specimens of various apparatus were shown to the members and proved immensely interesting to all.

Following Major Harris' speech, an animated discussion took place, the speaker answering questions put to him by the members.

The next meeting was fixed for Friday, March 12th.

Anyone desirous of becoming a member of the Leicestershire Radio Society should communicate with the Hon. Sec.,

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W. J. Rowlatt, 7, Highfield Street, Leicester.

* * *

GLASGOW & DISTRICT RADIO CLUB.
(*Affiliated with the Wireless Society of London.*)

At a meeting of the Club held at 30, Gordon Street, Glasgow, on Wednesday, 4th February, it was decided that the subscription be fixed at 2s. 6d. per annum, and that the Club become affiliated with the Wireless Society of London. Thereafter Mr. Adcock gave a most interesting lecture on "Directional Wireless," and Mr. Dewar, on behalf of the North British Wireless Schools, offered the entire use of a room at 206, Bath Street, as a Club Room, with occasional use of an excellent Lecture Room. This kind offer was gratefully accepted, and the new room will be used at the next meeting of the Club, on March 3rd.

At this meeting a lecture on Valves will be given by Mr. Snodgrass, and it is hoped that members will keep this night free.

Meanwhile will any readers who wish to join the Club communicate with Mr. R. A. Law, 7, Queen's Gardens, Glasgow?

* * *

BRIGHTON RADIO SOCIETY.

This Society was formed on January 19th, 1920, when 14 members were enrolled. Mr. J. E. Sheldrick, B.Sc., of the Brighton Technical College, has kindly consented to be President and has promised to conduct a series of lectures, some of which will be illustrated by lantern slides.

The second meeting of the Society was held on January 23rd, 1920, at the Y.M.C.A., Old Steine, and was well attended. Among the subjects under discussion was the proposed apparatus for the Society's station, and it was announced that the matter was well in hand. The aerial is a matter for further consideration.

A Committee of eight was elected which will meet shortly to discuss important business. At the close of the meeting eleven more applications for membership were handed in.

The third meeting of the Society was held at the Y.M.C.A., Old Steine, on January 30th.

The Secretary announced that Mr. Chapman, the genial Secretary of the Y.M.C.A., Old Steine, who has taken such a kindly interest in the Society, has allowed the use of a room for meetings, and has also offered the use of a lantern and screen for lectures.

An interesting exhibition of home-made wireless apparatus was held during the evening.

Arrangements were made for meetings to be held every Friday evening at 7.30 p.m. at the Y.M.C.A., Old Steine (Basement). Full particulars of the Society can be had upon application to the Secretary, Mr. W. P. Rogers, "Grasmere," Dyke Road Drive, Brighton.

* * *

THE WOOLWICH RADIO SOCIETY.

The officials of the Society are:—Secretary, Mr. James M. Ellam, 27, Nightingale Place, Woolwich, S.E.18; President, Col. Cousins, C.M.G., R.E. (o/c. Signals Experimental Establishment, Woolwich Common); Vice-President, Mr. A. Hogg (Principal of the Woolwich Polytechnic); Lecturer, Mr. W. James.

Mr. Ellam will be pleased to hear from other Wireless Clubs with a view to exchanging ideas, etc., and generally "pulling together."

For the time being meetings will be held every Friday in the Woolwich Polytechnic, William Street, Woolwich (by kind permission of the Governors of the Polytechnic).

On January 16th, Colonel Cousins, C.M.G., R.E., gave an interesting lecture on "The History of Wireless

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in the Army," bearing on its early struggles and rapid advancement.

Other lectures are being arranged, and it is hoped, in due course, to fix up a station, and to carry out some interesting and instructive experiments as soon as the G.P.O. licence is obtained.

It has been decided to affiliate the Club with the Wireless Society of London.

* * *

Bristol Wireless Association.

The opening meeting of the Bristol Wireless Association was held at 11, Leigh Road, Clifton, on January 24th, at 8 p.m. The business included a motion to affiliate the Association with the Wireless Society of London, which was heartily agreed to.

The Hon. Sec. (*pro tem.*), Mr. A. W. Fawcett, 11, Leigh Road, Clifton, would be glad to hear from any one wishing to become a member of the Association. The subscription is 5s. per annum. Members have the privilege of bringing friends to meetings.

* * *

The Sheffield and District Wireless Society.

The weekly meetings continue to be well attended, and the membership is gradually increasing as the work of the Society becomes more widely known. The difficulty of securing permanent headquarters is proving a serious handicap, but vacant rooms in Sheffield are apparently at a premium at the present time.

The following fortnightly papers have been read by Members:—

"Amateur-made Wireless Gear" by Messrs H. O'Neill and C. H. Handford, who described in detail how receiving and transmitting gear could be easily and simply made.

"The Æther." This formed the subject of a splendid lecture by Mr. J. G. Jackson.

"The Ionic Valve" was the title of an instructive paper by Mr. W. Forbes Boyd. The Author, who has carried out a good deal of experimental work in connection with the application of thermionic valves to aircraft, showed a thorough grasp of his subject.

A very interesting discussion followed, and the Secretary announced that a practical demonstration with a 3-valve amplifier would be given at the next meeting, using an indoor aerial.

Hon. Sec., Mr. L. H. Crowther, 156, Meadow Head, Norton, Woodseats.

* * *

The Amateur in Belgium.

Le Cercle Belge d'Etudes Radiotéléraphiques, founded in 1914, is reviving its activities and intends to become a wireless society of the first order. It wishes friends in allied countries to know of its existence and desires communications from other clubs. The Secretary is M. Pierre Tollenaere, 209, Bd. Leopold II., Brussels.

* * *

Wanted.

To form Wireless Clubs at Chelmsford, Croydon, Birmingham, Edinburgh, Halifax, Spalding and Doncaster. Those interested should communicate with: Mr. C. E. Jackson, 3, Seymour Street, Chelmsford; Mr. A. F. Lake, 318, Brighton Road, South Croydon; Mr. A. H. Staples, Y.M.C.A., Dale End, Birmingham; Mr. W. Winkler, 9, Ettrick Road, Edinburgh; Mr. J. R. Clay, "Woodview," Sowerby Bridge, Yorkshire (for Club in Halifax); Mr. A. H. Wasley, Glenholme, Ravensworth Rd., Doncaster.

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Aviation Notes

AIRCRAFT WIRELESS ON THE LONDON-PARIS AIRWAY.

MAJOR N. B. TOMLINSON (late R.A.F.), is at present in charge of the Communications Department, which comprises the Wireless Organisation and personnel of the enterprising Aircraft Transport and Travel Company, of whom Mr. Holt Thomas (Chairman of Directors), and General Francis Festing, C.B., C.M.G. (Managing Director), are the leading spirits. Major Tomlinson has been connected with the Aircraft side of wireless engineering since 1911, in which year he was engaged on behalf of the Marconi Company in experimental work at Brooklands and Farnborough. During the war his experience has ranged over the fitting of W/T. gear to airships, airplanes, seaplanes, armoured trains, motor cars, and motor boats,—a striking illustration of the wide field of wireless work in modern warfare.

Major N. B. Tomlinson.

The cause of commercial aviation, when it wins through the present preliminary period of vicissitude to final success, will owe much to the untiring efforts and financial enterprise of Mr. Holt Thomas and his colleagues, and to the devoted labours of the flying and technical staff associated with them, who together have borne the brunt of travail that is the portion of those who lead the way and clear the path for others to follow.

The solid achievement represented by maintaining a practically uninterrupted daily service of aeroplanes in each direction between London and Paris throughout the severe conditions of last autumn and the present winter has won the genuine admiration not only of the man in the street, but also of those who have some inner knowledge of the almost insuperable difficulties that have been so successfully met and overcome.

* * *

WIRELESS EQUIPMENT.

Apropos of the question of wireless gear, Major Tomlinson explains that the demands of the moment call for a small, fast type of craft in which it is not feasible to provide special accommodation for a wireless operator. The pilot has too much on his hands, as can well be imagined under the present circumstances, to carry out the additional duties of a skilled Morse operator, so that, for the time, the undoubted advantages of telegraphy for the longer ranges have been outweighed by the com-

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parative simplicity of the wireless telephone equipment.

The apparatus at present in use is the latest aircraft telephony set manufactured by the Marconi Company. It is so arranged that the only parts requiring manipulation by the pilot are the winding gear for dropping and winding-in the aerial, and the receiver adjustment by means of which signals are strengthened and weakened as the pilot leaves or approaches the station with which he is working. The H.T. generator is driven by a small air screw working in the slip stream of the main propellor.

* * *

W/T. COMMUNICATIONS *EN ROUTE.*

A wireless telephone receiver has been installed on the roof of the Company's Office in Old Queen Street, Westminster, by means of which it is hoped to maintain communication with planes from the time of leaving the London terminus of the London-Paris Service until they have crossed the French coast, a distance of some 70 miles. This will enable the London Office to know the whereabouts of their machines in all weathers until they are in France, and on the return journey to have all arrangements made for their reception and the speedy forwarding of passengers, mails, and goods to their respective destinations.

The W/T. Stations along the London-Paris Airway at present are Hounslow, Lympne (near Folkestone) and Le Bourget (near Paris). Once a pilot is out of touch with Lympne he must wait until he is within 60 miles or so from Paris before he can again pick up the Communication Service. It is hoped in the near future to erect an additional station in France to fill this gap and to enable the pilot to keep in continuous touch with the ground throughout his flight. This will be of great advantage, particularly in keeping the pilot advised of the weather he may expect to meet ahead of him. In winter time especially, the weather may change completely within the course of an hour or two, and local fogs appear and disappear with great suddenness.

* * *

FOG TROUBLES AND D. F.

Really dense fog is the bugbear of present-day flying and represents practically the only climatic conditions which really trouble the pilot. The aeroplane as a machine is not prevented from flying by fog, but the pilot is practically rendered blind, and therefore helpless in the matter of navigating his craft or landing it.

But with a perfected system of Directional Wireless, this difficulty practically disappears. Irrespective of mist or fog, or whether landmarks are visible or not the course will be determined by the constant signals received from beacon stations at known points either on or off the line of flight, but preferably at the destination end. The pilot can detect instantly from the signals, especially if "homing" towards a beacon, should he veer in any way from the set course, and is able to correct his line of flight accordingly.

* * *

THE VALUE OF WIRELESS.

Mr. Holt Thomas explains that when his present arrangements are completed, as they will be before the ensuing winter, he hopes to be independent of all but exceptionally severe weather conditions. "Wireless," he adds, "will help us enormously. We have now the services of one of the most practical experts in this country, who is concentrating his attention exclusively on the question as to how directional wireless and the wireless telephone may be made to help us in regular daily flying, and to overcome such difficulties as at present cause delay."

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Aircraft Wireless Section

Edited by J. J. Honan (late Lieutenant and Instructor, R.A.F.).

These articles are intended primarily to offer, as simply as possible, some useful information to those to whom wireless sets are but auxiliary "gadgets" in a wider sphere of activity. It is hoped, however, that they may also prove of interest to the wireless worker generally, as illustrating types of instruments that have been specially evolved to meet the specific needs of the Aviator.

SHORT-WAVE TUNER (MARK IV.).

This set is smaller and even more convenient from the point of view of portability than the Mark III. It is designed to receive wavelengths between 90 and 320 metres.

As will be observed from the skeleton wiring diagram in Fig. 28, the telephones are permanently connected in the closed circuit so that the advantage of having a stand-by position is lost. Again, the buzzer can only be applied to the open circuit.

The open-circuit inductance is a fixed inductance of two values, the portion L_1

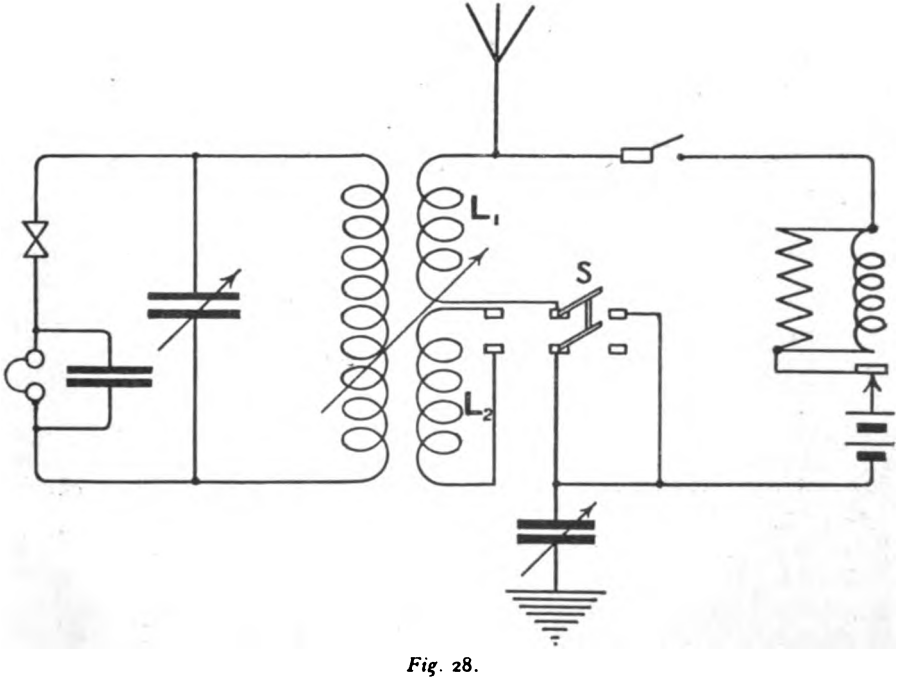

Fig. 28.

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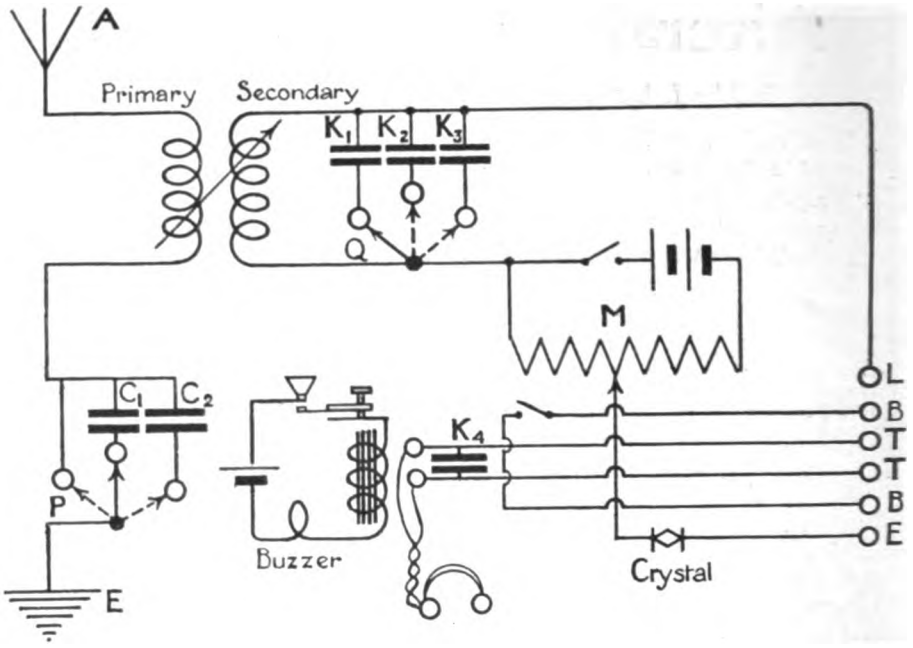

Fig. 29. Schematic wiring diagram of Tb Receiver.

being permanently in circuit, whilst the portion L_2 can be cut in or out by means of a switch S for long or short wavelengths. The open and closed inductances are of the pancake type and are coupled eccentrically.

Only one detector crystal (perikon) is fitted, so that the potentiometer battery is eliminated.

THE Tb RECEIVER.

This was one of the first crystal receivers actually used for work in the air, mainly by the R.N.A.S. It forms one of a series ranging from Ta to Tf which have done very useful work.

As a fairly exhaustive description has already been given of a typical crystal receiver (the S.W.T. Mark III.) it will be sufficient to point out one or two of the characteristic features of the present set.

AERIAL CIRCUIT.

By means of a switch handle P, Fig. 29, the aerial can be used without a condenser, thereby giving the natural wavelength, or the condensers C_1 or C_2 can be inserted in series for shorter wavelengths.

The primary of the magnetically-coupled tuning inductance is varied by means of a switch tapping eleven contact points.

CLOSED CIRCUIT.

The secondary condenser K_1 K_2 K_3 is so arranged that any one of three values can be thrown into the circuit by means of a handle Q.

The secondary of the tuning inductance has 12 contact studs. Coupling is varied by means of a slider, and since the whole of the aerial and secondary inductances are involved, any variation in

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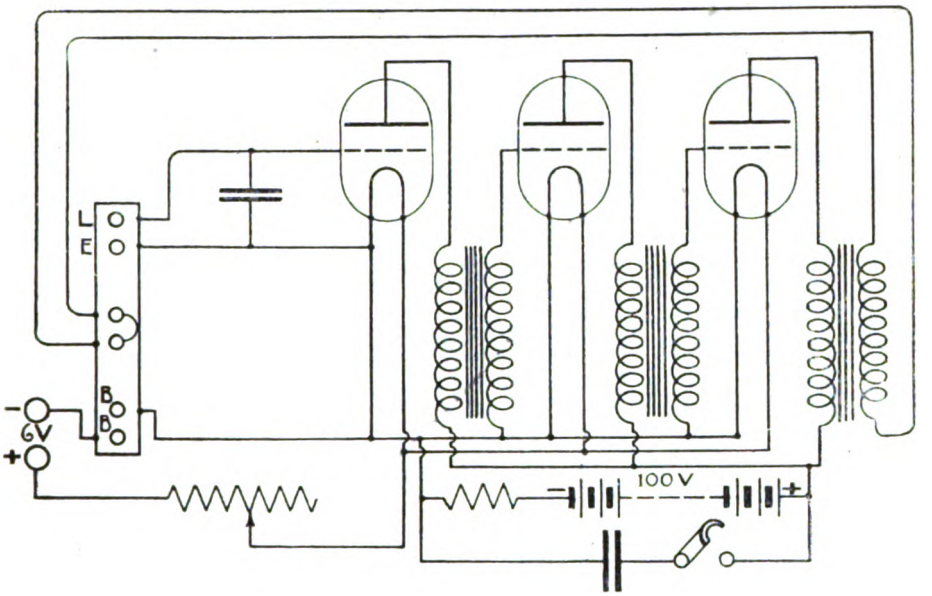

Fig. 30.

the degree of coupling will cause a sufficient alteration in the mutual inductance value of the combination to affect the tuning, which must consequently be re-adjusted.

DETAILS.

The carborundum crystal is adjusted by means of the potentiometer M. A shunt condenser K_1 is placed across the telephone terminals. A testing buzzer is provided and is worked from a dry cell, separate from the potentiometer battery.

The plug, BTTBE provides connection with a Brown Relay, or with the three-valve amplifier shown in Fig. 30, connection being made between the terminals designated by the same letters in each diagram.

A special plug closes the potentiometer battery (and the relay battery when it is used), and is so arranged that when it is in its operative position it is impossible to close down the front lid of the receiver. The object of this is to prevent the batteries from being left on and needlessly exhausted during such time as the receiver is out of action.

Aircraft Wireless in the New Volume

No up-to-date wireless magazine can afford to ignore the development of wireless in co-operation with Aviation. We have therefore arranged to publish regularly articles dealing with research, achievement and commercial developments in connection with this subject, written by men actually engaged in the work.

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The Library Table

INDISCRETIONS OF THE NAVAL CENSOR.

By Rear-Admiral Sir Douglas Brownrigg, Bt.

London & New York, Cassell & Co., pp. 280, 12s. 6d. net.

THIS is one of the most pleasant of the post-war books by men who held high positions during the hostilities which we have read. It contains no attacks nor is it meant to justify the author's actions—thereby serving that very end the better—but is simply the story of his work in what must have been the most "ticklish" position filled by any man at the home front. Sir Douglas Brownrigg performed an arduous, and to a large degree thankless, task and relinquished his duties without taking with him a single rankling thorn. He recalls in charming fashion a number of occasions on which he or his department came into sparking contact with higher authorities, but there is no trace of bitterness and the hearty laugh is always near. As he spins his yarns one can imagine him jovially slapping his victims on the back. He did his duty to the best of his ability, standing aside for no one save his superior officers, allowing nothing to put him out of his stride, and asking no praise. His book bears the imprint of a serene conscience; it is simple and hearty and wholesome.

Sir Douglas deals with many things which once mystified us, such as the first British official report of the Battle of Jutland, the loss of the *Audacious*, and the death of Lord Kitchener, not without making one feel guilty of having formed hasty and unjust opinions of censors. Incidentally he reveals how multifarious were his duties. These were not confined to muzzling the Press and deleting the most thrilling portions of letters, but included the production of cinematograph films, the organisation of specially conducted trips to the Fleet, the supply of first-class music hall artists to such units as bade them welcome, and the hunt for authors and artists to depict various scenes and incidents of the war. Who would have thought that it was our common enemy, a Censor, who induced Mr. Kipling to write those wonderful articles about Jutland? We can forgive him much on that score alone.

In the chapter on wireless and war news the general public is enlightened about a matter on which it was for the greater part very hazy. How could we receive German war news? Why did the enemy send it to us? Who took it down? These questions were put to the writer many times during the war, but the querists never seemed to be wholly satisfied with the replies, partly because one was morally bound to be exceedingly sketchy and vague in speaking of those things and partly because even at that time the man in the street had not grasped the fundamentals of wireless.

In his preface Sir Douglas confesses himself to be painfully aware that his book shows no trace of literary merit. Well, we will not argue that point with a writer who gives us a book which we could not lay down until we had read it from cover to cover. The chapters about authors and publishers and the pressmen of allied countries are little works of art.

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The Construction of Amateur Wireless Apparatus

This series of articles, the first of which was published in our April number, was originally designed to give practical instruction in the manufacture of amateur installations and apparatus, and arrangements had been made with Marconi's Wireless Telegraph Co., Ltd., to supply complete apparatus to the designs it was intended to detail. The restrictions on amateur work, however, remained in force, and the author was compelled to proceed on general lines only. A further series will be published giving the class of information originally intended.

Article Twelve.—RE-CONDITIONING OF PRE-WAR STATIONS.

IN our last article we considered certain simplified circuits for the amateur's use, and made some remarks concerning interference on a self-heterodyne receiver of the direct coupled variety. The reader may be somewhat puzzled to realise how the feeble radiation resulting from such a receiver can possibly cause any appreciable interference. It should perhaps be mentioned in passing that any aerial system which is picking up signals is always also radiating small amounts of energy due to the oscillations which are built up in it by the incoming waves. It is impossible to design a circuit which is a good absorber of radiation and yet not also a good radiator. In fact, broadly speaking, the conditions which have to be satisfied in designing a good absorbing (*i.e.*, receiving) circuit are precisely those which make the circuit a good radiator. As a rule, however, this tendency of a receiving aerial to re-radiate some of the energy it picks up does not cause trouble at other near-by receiving stations, because the amount of energy so re-radiated is extremely small. If the energy picked up by the aerial is of the order of a micro-watt, as is usually the case, it is evident that the amount which is re-radiated must be even less than this. Such amounts could only give trouble at other stations if these stations were very near indeed (as for instance, in the same building) or were using extremely sensitive apparatus. Cases do occur at times however when large receiving aerials, receiving high power stations on long wavelengths, pick up sufficient energy to re-radiate an appreciable amount, at frequencies which correspond to harmonics of the original waves as well as at the fundamental wavelength. These harmonics have been known to give quite readable signals at short-wave receiving stations distant perhaps a mile or two from the large receiving aerial.

The amount of radiation from a self-heterodyne set is of quite a different order to the above, owing to the fact that the oscillations are now being built up in the aerial from a local source which is quite capable of supplying an amount of energy some thousands of times as great as any incoming signals can give. Considering for a moment the simple circuit shown in Fig. I in the article in the February number, it is quite easy, by suitable design of windings, to build up oscillations in the circuit " A " of similar strength to those which could be obtained by exciting the circuit with a

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buzzer; and it is well known that it is possible to communicate over a range of some miles using the energy of a buzzer, with ordinary receivers. It is unlikely that under ordinary conditions of heterodyning the oscillations built up would be quite as strong as this, but on the other hand, when the radiation from the aerial caused by these oscillations arrives at another receiving station using heterodyning methods, it will be picked up by a receiver which may be many hundred times as sensitive as an ordinary crystal set. This being the case, the range at which it will give annoying interference with such receivers will probably be greater than that at which a buzzer could be picked up by a good crystal receiver.

In view of the fact that amateurs are at last able to resume practical work, it does not appear out of place to conclude this series of constructional articles by offering a few suggestions of a reconstructional nature, which may be of some use to those who are now overhauling and re-erecting old sets which have been dismantled since the beginning of the War. A few hours of careful examination of the gear before erection may possibly be rewarded by subsequent freedom from as many days of vexatious search for the cause of a complete absence of signals on a receiver which used to give as good results as could be desired.

The aerial will in many cases have to be designed afresh, owing to the present restriction of the amount of wire used to 100 feet of single, or 70 feet of double conductor. The type chosen will, of course, depend on the nature of the site, but in view of the small amount of wire permitted, it is more than ever necessary in planning the aerial to arrange it in the form in which it will be least screened from radiation. If the double-wire type is chosen the two wires must be separated by a distance of several feet, the more the better. If they are closer than this, very little better results will be obtained than with a single wire of the same length. If in any case masts have been erected to suit aerials which have now to be shortened, the length of span can be made up with cord separated from the wire itself by good insulators.

The spreaders, if any, should of course be located at the mast end of such cords, and not at the wire end.

The earth. It is particularly necessary with the new short aerials that the length of lead to the earth should be as short as possible, and that the resistance of this lead and of the earth itself should be as small as possible. No reliance should be placed in any earth system which has been buried without attention for some years. In cases where it is not practicable to bury plates close to the receiver, capacity earths of wire netting of close mesh, laid on the ground near the receiver, will be found to improve the results obtained.

Insulators. It is in the insulation of the set that the greatest deterioration is likely to be found. Porcelain and glass will be little affected, and will probably only need cleaning. Rubber will almost certainly have perished and need replacement. Ebonite will often look worse than it really is. All the old surface should be removed by scraping. If the material appears sound underneath it may be finished with coarse and then fine emery paper, and used again. In any case in which the deterioration appears to have gone much below the surface, the insulator should be scrapped, as its use will only lead to leakage and consequent inefficiency of working.

Coils should be carefully dried out by gentle warming. Any damp in the insulation of the windings, or in the

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formers on which they are wound, will lead to leakage and inefficiency. After drying out, coils should be treated with shellac varnish, which also should be thoroughly dried before the coils are used. All soldered connections or tappings should be examined and remade if they appear in any way faulty. Coils should be tested for continuity at every point by means of a telephone and dry cell, used as in Fig. 1. If the windings of the coil are intact, a click will be heard in the telephones every time that the circuit is made or broken. If, however, there is any fault in the windings nothing will be heard.

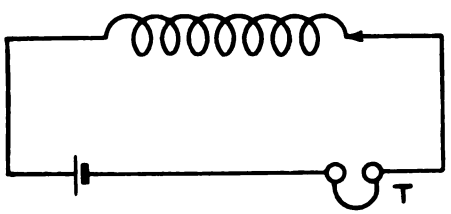

Fig. 1.

Condensers, if with a dielectric of ebonite, should be opened up and examined. If the dielectric is of air, glass, mica or similar material, they are not likely to have deteriorated much, and should not be interfered with unless there is any particular reason to suppose them faulty.

Switches should be carefully cleaned and tested for continuity in the same way as coils.

In connecting up the set, aerial leads inside the receiving room should be well insulated. Best results will be obtained if they are run in small fibre or porcelain cleats. Connections in the receiver itself should not be longer than necessary, and should be run neatly and fastened in place permanently. Wires left hanging about will be found to have an uncanny knack of fouling and causing a short circuit of some part of the apparatus just at a most inconvenient moment. Also, if all leads are fastened down neatly in such position that their exact course can be seen at a glance, not only will the appearance of the set be improved, but much time will be saved in tracing any faults such as disconnections which may arise in working. In deciding the position of the various pieces of apparatus, care should be taken to keep the different circuits apart. Coils should be so disposed that the coupling between them is as small as possible, except in the case when they are intended to be coupled together.

When the set is erected, all parts should be tested for continuity in the manner described above. If a testing galvanometer is available the earth should be tested by running a lead from some part of the aerial circuit through a dry cell and the galvanometer to another earth, such as a water pipe. For the purpose of this test it does not matter if this lead is quite long, provided it is not of too fine wire. If the earth of the set is good, a quite good deflection should be obtained on the galvanometer. The insulation of the aerial can then be tested by disconnecting the earth from the aerial at some point below that at which the lead is taken off. No deflection should then be obtained. This test will show up any definite short to earth on the aerial, but is not delicate enough to detect a small leak over an insulator. In the above tests, if an aerial tuning condenser is fitted it should be shorted.

In the new series of these articles which starts in the next volume information will be given on the details of practical design and construction of apparatus described in general terms in this series. As previously explained, it was originally intended to do this in the present series, but the plan was of necessity postponed owing to the non-removal for so many months of the restrictions on amateur working.

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Questions and Answers

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless telegraphy. Readers should comply with the following rules:* (1) *Questions should be numbered and written on one side of the paper only, and should not exceed four in number.* (2) *Queries should be clear and concise.* (3) *Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before.* **(4) The Editor cannot undertake to reply to queries by post.** (5) *All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or if so desired, under a "nom-de-plume."* **(6) Readers desirous of knowing the conditions of service, etc., for wireless operators will save time by writing direct to the various firms employing operators.**

G.H.S. (Hull).—A 220-volt supply will be quite satisfactory for a "Q" valve, provided that it is direct and not alternating. The value of 200 volts given as a maximum is a rough approximation only, and it is often possible to use a good deal more than this quite satisfactorily.

J.A.W. (S.S. Pearlmoor).—(1) We are afraid that the exact losses due to a jumper stay of only partly defined dimensions, situated near to an aerial of unstated length, carrying an unknown current, are quite incalculable,—without the additional complications of sparking between the stay and the mast, and other intermittent contacts. We are sorry, but the problem is rather beyond us! (2) The rough note you mention is sometimes due to too low a supply voltage. You can check this of course by noting what volts you get on the A.C. side. Incidentally, we may mention that it is very risky to put the transformer in series on the condenser in parallel unless the voltage is very low. The result of this experiment is often a pleasant half day spent in replacing broken plates in the condenser. Another possible cause of the roughness of the note may be unevenness of the disc studs. (3) We can recommend Bangay's Oscillation Valve, and Goldsmith's Radiotelephony. We do not know of a book dealing exclusively with direction-finding, and do not think that you would require one. You will get some account of this part of the subject in most of the better books on Wireless Telegraphy. (4) It will be more satisfactory if you apply direct to The Secretary, G.P.O., London.

A.F.L. (South Croydon).—There is nothing very remarkable in your hearing a wireless 'phone on your ordinary receiving set. Ordinary detectors though quite incapable of receiving C.W. are able to make audible the audio-frequency variations of the C.W. by which the speech is transmitted. You would of course not get the range that you would with a set designed for the purpose, but the station you heard was probably Hounslow, which is only a few miles from you, and uses a good deal of power. You will very likely hear him state who he is when you hear him again.

"SPARKS" (Exeter).—(1) We think the aerial with the horizontal top 40 feet long will be the better of the two arrangements you suggest. At any rate it will be a good deal the cheaper, as you will need much less wire, and this appears to be a consideration in your case. It should give the better signals too. (2) Two parallel wires are better than a single wire provided that the distance between them is some feet at least. If you put them closer together than that the results are practically no better than with a single wire. (3) The gauge of wire is not very important, provided that it is heavy enough to withstand the mechanical stresses to which it is exposed. The thicker you make it the less will be its resistance, and therefore the less the loss of energy due to that resistance. (4) There is no simple way of satisfactorily receiving long waves on a very short aerial. It can only be done with special apparatus and methods which are beyond the range of a beginner. You would be much better advised to commence with a set for short and medium waves only. You will find the information you require for this in the instructional articles published in the WIRELESS WORLD, or in any handbook for amateurs.

C.S. (Penrith).—The probable reason of your not getting sharp tuning is that the capacity of the receiving condenser is too small, if the dielectric is ¼ inch thick. With a condenser such as this, unless the plates were very large, the capacity of the coil itself would probably be important. The sound you got with the condenser disconnected would probably not be due to direct induction from the buzzer, but to forced oscillations set up in the receiving coil by the oscillations in the transmitting circuit, owing to the coupling between the circuits being too great.

F. J. K. (Co. Kerry).—It is quite possible to test the main condenser of a 1½ k.w. set by the method you suggest. A better method,

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however, is to test each bank separately. Reduce the gap between the spark rods of the induction coil to about 1 or 2 millimetres and if a spark is obtained on pressing the key the condenser is in working condition. If no spark is obtained open up the condenser and repeat the test when the broken plate can be located.

(2) A 450-metre wave can be obtained on a 1½ k.w. set by using one-half of the main transmitting condenser, and with the transformer secondaries in parallel.

A better method perhaps would be to take a tapping off the jigger primary, using the condenser banks in parallel.

(3) A condenser placed in a circuit in which direct current is flowing would act as a very high resistance, in fact as an insulator, and, therefore, no current would flow in the circuit.

When a condenser is placed in an alternating current circuit the condenser sets up a back electromotive force which is equal and opposite to the applied E.M.F.

Imagine a simple circuit containing a condenser and an alternating pressure applied to its terminals. Let the pressure be in a positive direction increasing from a minimum to a maximum. As soon as a pressure is exerted on a condenser a B.E.M.F. is set up which opposes the charging pressure. When the charging pressure becomes a maximum the condenser has its maximum charge. As soon as the charging pressure is reduced the condenser starts to discharge in a negative direction, and will continue to discharge until the applied E.M.F. is zero.

Now the applied voltage will increase to a negative maximum during which time the condenser current will decrease to zero.

Thus during the first and third quarter periods the current is flowing with the pressure, while during the second and fourth quarter periods the current is flowing against the pressure.

C.T.A. (Leicester).—Without actually trying out your telephone transformer it is impossible to give a definite opinion as to whether it is suitable or not, but we think it would be well worth your while to make it up and try it out. Use a condenser across the primary of about .0002 mfd. A condenser across the secondary is not required, but if you do decide to use one make it about .05 mfd.

It would be advisable to immerse the transformers in hot paraffin wax in order to ensure good insulation between the turns.

C.E.B. Mech. W/T.—Asks why, unlike a crystal receiver, better results are obtained with a valve receiver when the detector circuit is coupled directly to the aerial instead of being inductively coupled?

We cannot agree with C.E.B. that better results are obtained with a valve if coupled directly to the aerial.

A crystal detector needs a certain oscillatory E.M.F. in order that it shall detect incoming signals. Now if the aerial be small and the received wavelength long the amount of inductance required would be sufficient to apply the required E.M.F. to the crystal. In this case a crystal directly connected to the aerial would be sensitive. On the other hand, if the aerial is large and the received wavelength short little inductance would be required in the aerial, and the voltage across this inductance would be too small to affect the crystal. Hence a secondary circuit with small capacity and large inductance would be necessary.

The same remarks apply to valve receivers, the only difference being that valves do not require such a high oscillatory E.M.F. as a crystal, and can, therefore, be tapped off smaller inductances than can a crystal.

E.K. (Newport, Mon.).—Has been trying experiments with the 1½ k.w. rotary converter and finds that if the slip rings are short-circuited and the starter handle is moved to the first stop, the armature gives little jerks, continually starting and stopping. Why is this?

When the starter handle is moved to the first stop a current will flow in the D.C. armature winding causing the armature to revolve. Now the slip rings are tapped off the D.C. armature winding at opposite points. When these two points come under two opposite brushes, the D.C. supply is momentarily short-circuited, causing the armature to pull up. This short-circuit will be only momentary owing to the ineritia of the armature.

We should like to point out that this experiment is not conducive to the well-being of the rotary, owing to the heavy current that will flow in the D.C. windings, besides the bad effect of short-circuiting the D.C. supply.

ENQUIRER (Leek) (1) (2) and (3).—These questions can be answered only by the firms themselves. We advise you to apply direct.

J. G. (Cork).—Yes, the wearing of uniform is compulsory for wireless operators on board ship.

F. J. K. (Cahirciveen) (1).—The method for testing the condenser bank is quite sound. In practice it is more convenient to isolate the two halves of the bank before applying the test, as by this means the broken down half can be at once traced. (2) The arrangement would give about 425 m., which might be brought up somewhat by the sliding inductance. This is the nearest that the set will give to 450 m. The fixed gap would not be necessary. (3) A condenser entirely prevents the passage of D.C. It will, however, allow the passage of A.C., but not without altering the phase relation between the current and the applied E.M.F.

J.G.R. (Enniskillen).—(1) In order to use your low resistance 'phones you will need a telephone transformer, which consists of two

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separate windings on a core of soft iron wires. One winding is of comparatively few turns of not too fine wire, say, No. 30, wound to have a resistance equal to that of the 'phones. The other winding consists of many turns of very fine wire, say, No. 36-40, having a resistance of at least 5,000 ohms. The high resistance winding is connected in the position shown for the high resistance 'phones. Your low resistance 'phones should then be connected across the low resistance winding. See article in this issue for further details of the practical construction. (2) " D.W.S.22 " means wire of gauge No. 22, insulated with a double winding of silk. (3) Any other copper wire will do for the aerial, provided that it is sufficiently heavy for mechanical strength. The dimensions need not be altered. (4) This receiver was designed especially for the benefit of beginners such as yourself, in order that you should be able with very little experience to make a fairly efficient set. It could not be altered for greater range and selectivity without entirely re-designing it,—which, of course, we cannot undertake in these columns. We recommend you to confine your attention to the type shown until you possess greater experience. You will then find many other suitable types described in this magazine.

A.G.B. (Corsham).—(1) The circuit you refer to is quite obsolete, and we do not think it was ever used in practice. We have tried in vain to get further information as to the constants of the circuits employed. Your explanation of the action of the balanced crystals is quite correct. We think that there is an error in Bucher's statements with regard to the pitch of the note. With the values of the incident frequency and buzzer group frequency he gives, the pitch should be either 100 or 4,900, or a mixture of the two, depending chiefly on the damping in the circuit B. (It may, of course, be a mixture of these two values.) If the damping in B is excessive, a signal will only be obtained when the maxima due to the incoming radiation and the buzzer radiation exactly coincide, and the pitch should therefore be 100. If, however, the damping is negligible, there will always be a coincidence of maxima, and the pitch should therefore be that of the buzzer trains. (2) The apparent reason for the tuning of circuit B to a very high frequency is that by this means it is ensured that in each train of oscillations set up by the buzzer, at least one maximum should come near a maximum of the incoming radiation. This would not necessarily be true if the frequencies were nearly equal. (3) The oscillation transformer BJ will probably be about right with a similar amount of turns on each coil. (4) We are afraid we cannot suggest the best values for these condensers, which are probably used to diminish the shunting effect of the circuit J, across the crystals for the incident radiation.

STRATHMERE (Bayswater). —(1) The usual causes of false bearings are the presence of mountain masses in the region, the presence of deposits of mineral ores in the neighbourhood, and possibly the variation in conductivity of the earth in different directions from the receiving station—as for instance with a station on a rocky coast. (2) The aerial and its associated coils must of course be tuned to the incoming radiation. We do not think that any other relation between the Inductance and Capacity, subject to this condition, has been worked out. In considering the *mechanical* dimensions, the rough principle is to make the area of the loop as large as possible without the natural wavelength exceeding the desired value.

H.H. (Ely).—(1) There does not seem much wrong with your arrangements. However, the potentiometer connections in your diagram are quite incorrect. Consult any receiver diagram about this. This should not be enough to stop your getting any signals. Your earth is rather small. Try burying a lot more wire, and spread it more. If this is not convenient try wire netting laid on the ground. You should also insulate the lead-in more carefully,—the insulation at this point has probably chafed, and if the wooden wall is at all damp, you may be getting serious leakage there. Examine all your connections and insulation carefully. (2) No. (3) Yes, but get the set working without this additional complication first.

(We regret we are compelled to hold over many answers. In the next volume more space will be devoted to this Section, and we hope speedily to wipe out our arrears.)

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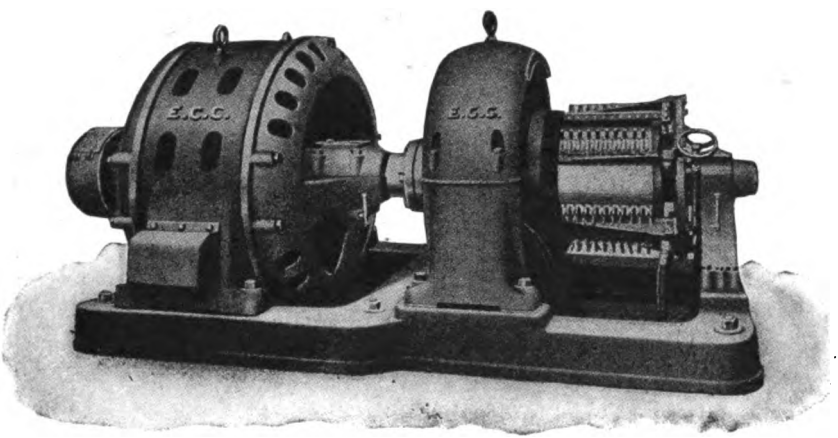

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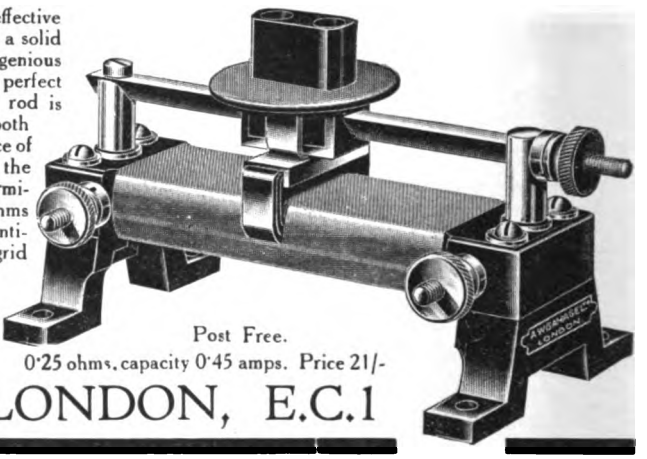

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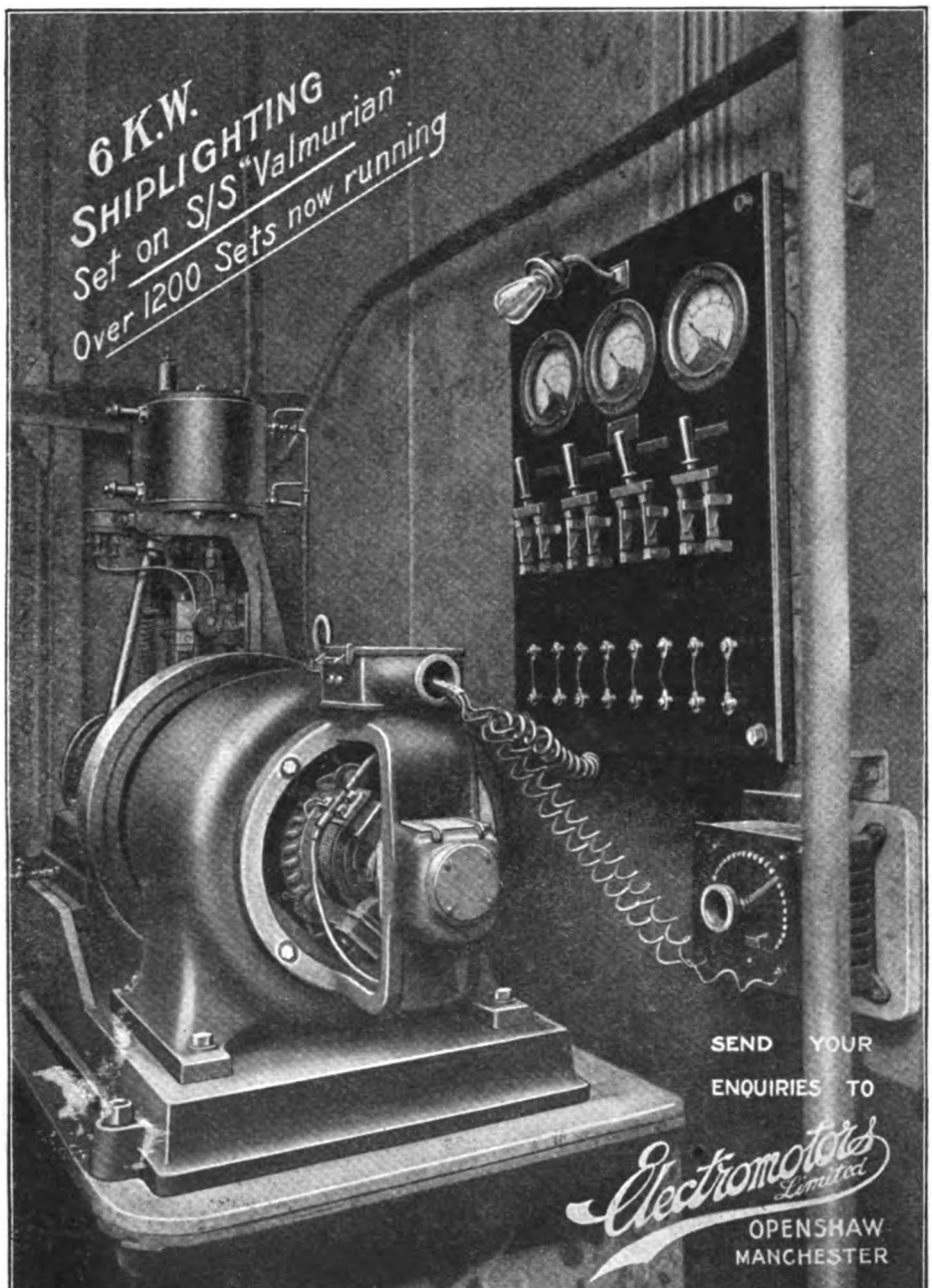

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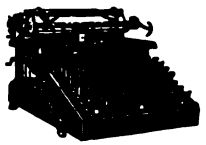

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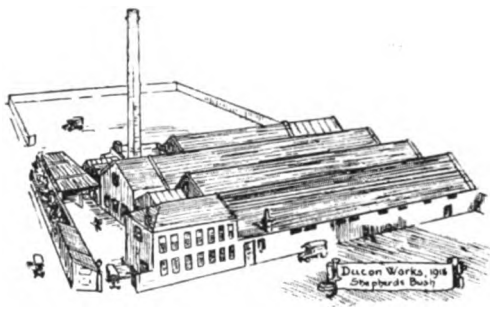

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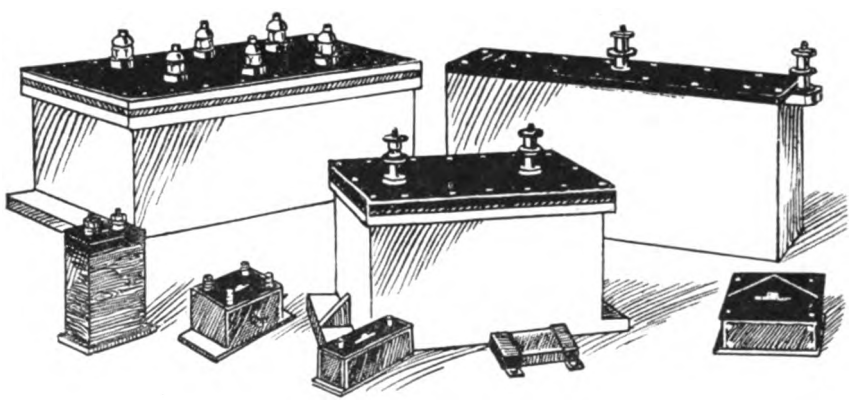

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Pelmanists *v.* Non-Pelmanists.

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"We most of us have competitors and rivals—and woe to the non-Pelmanist who tries to run the race and win against a Pelmanist." (F13131.)

The above letter has recently been received by the Pelman Institute. Some may consider it a remarkable letter. It is not a remarkable letter, however, from the Pelman point of view, as hundreds of equally striking letters are received by the Institute almost every day. But it contains certain points which will interest every reader.

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In the first place, it emphasizes the intellectual benefits of Pelmanism. "I have gained tremendously on the spiritual or intellectual side," says the writer. The practical, business, and financial benefits which follow from a course of Pelmanism are so striking that sometimes this particular feature of the Pelman Course is apt to be overshadowed. But it is always present all the same. The atmosphere of optimism, the bright keenness of spirit, developed by Pelmanism is testified to by thousands. Men and women of all ages and professions write continually to say how Pelmanism has benefited them intellectually, how it has given them a new outlook on life, how it has opened to them rich stores of knowledge and enjoyment unknown to them before, how it has rolled away the clouds of depression and unrest from their minds and enabled them to live fuller, richer, and happier lives. The records of the Pelman Institute are full of such cases. The good that Pelmanism is doing in this direction can never be over-estimated or too highly praised.

INCOMES QUADRUPLED.

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doubling, trebling, and quadrupling the income-earning power

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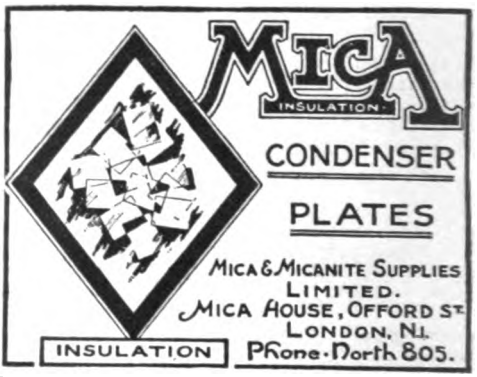

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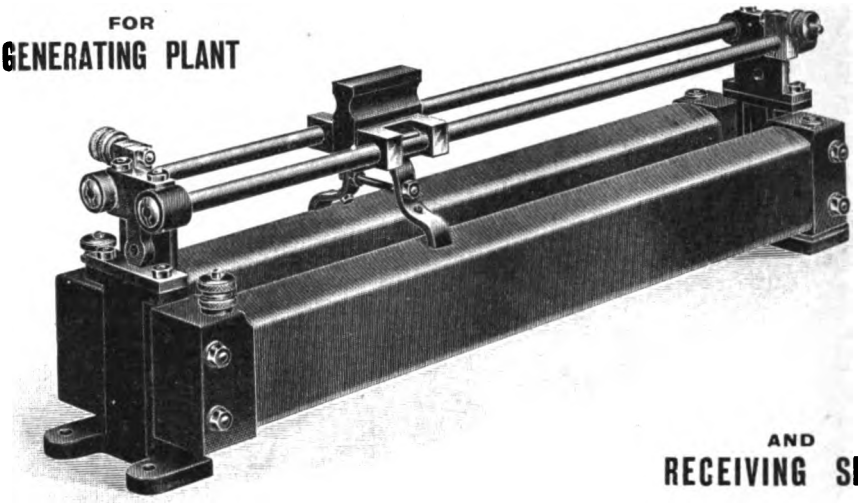

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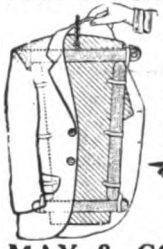

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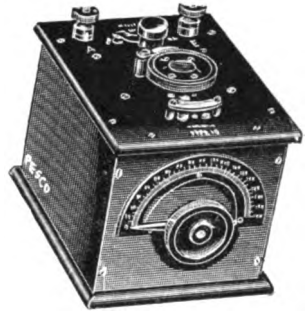

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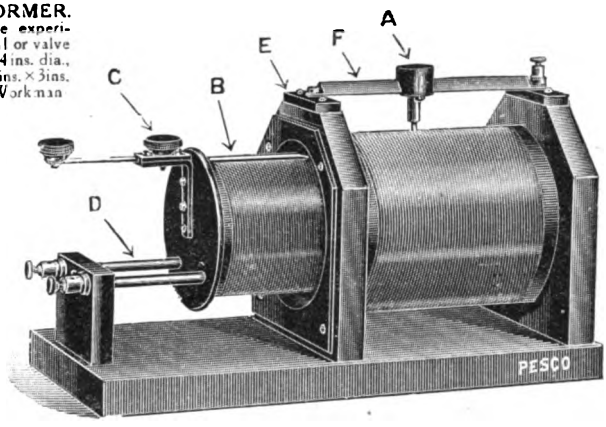

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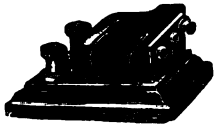

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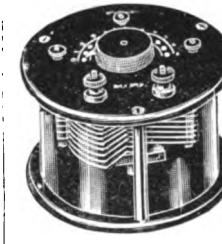

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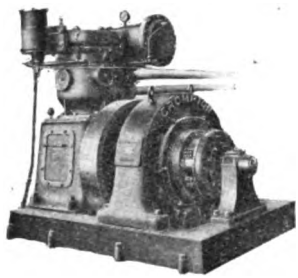

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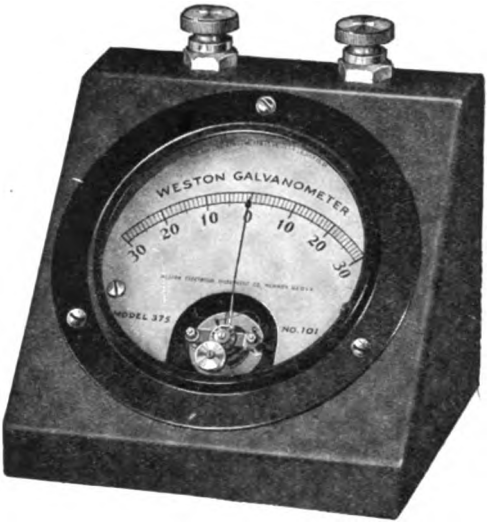

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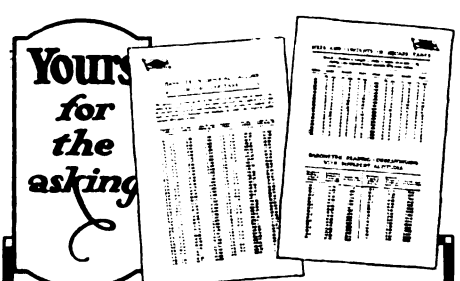

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